(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 April 2012 (26.04.2012)

PCT

(10) International Publication Number
WO 2012/054111 A1

(51) International Patent Classification:
A24D 3/06 (2006.01)

(21) International Application Number:
PCT/US2011/044142

(22) International Filing Date:
15 July 2011 (15.07.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/390;211	6 October 2010 (06.10.2010)	US
61/390,213	6 October 2010 (06.10.2010)	US
12/981,909	30 December 2010 (30.12.2010)	US
PCT/US11/20013	3 January 2011 (03.01.2011)	US
61/504,023	1 July 2011 (01.07.2011)	US
PCT/US11/43269	7 July 2011 (07.07.2011)	US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *with information concerning one or more priority claims considered void (Rule 26bis.2(d))*

WO 2012/054111 A1

(54) **Title**: SMOKE FILTERS FOR SMOKING DEVICES WITH POROUS MASSES HAVING A CARBON PARTICLE LOADING AND AN ENCAPSULATED PRESSURE DROP

(57) **Abstract**: Disclosed are filters, smoking devices, related articles and apparatus, and related methods. The filters include porous masses that have an active particle and a binder particle, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

SMOKE FILTERS FOR SMOKING DEVICES WITH POROUS MASSES HAVING A CARBON PARTICLE LOADING AND AN ENCAPSULATED PRESSURE DROP

Field of the Invention

The instant application is directed to a smoke filter for a smoking device having an element that enhances the smoke flowing thereover.

Background of the Invention

The World Health Organization (WHO) has set forth recommendations for the reduction of certain components of tobacco smoke in WHO Technical Report Series No. 951, *The Scientific Basis of Tobacco Product Regulation,* World Health Organization (2008). Therein, the WHO recommends that certain components, such as acetaldehyde, acrolein, benzene, benzoapyrene, 1,3-butadiene, and formaldehyde, among others, be reduced to a level below 125% of the median values of the data set. In view of new international recommendations related to tobacco product regulation, there is a need for new tobacco smoke filters and materials used to make tobacco smoke filters that are able to meet these regulations.

The use of carbon loaded tobacco smoke filters for removing tobacco smoke components is known. These filters include carbon-on-tow filters and carbon particulate contained within chambers of the filter. U.S. Patent No. 5,423,336 discloses a cigarette filter with a chamber loaded with activated carbon. U.S. Publication No. 2010/0147317 discloses a cigarette filter with a spiral channel where activated carbon is adhered to the channel's walls. GB1,592,952 discloses a cigarette filter where a body of continuous filaments surrounds a core of sorbent particles (*e.g.*, activated carbon) bonded together with a thermoplastic binder (*e.g.*, polyethylene and polypropylene). WO 2008/142420 discloses a cigarette filter where the absorbent material (*e.g.*, activated carbon) is coated with a polymer material (*e.g.*, 0.4-5 wt % polyethylene). WO 2009/112591 discloses a cigarette filter that produces little to no dust with a composite material comprising at least one polymer (*e.g.*, polyethylene) and at least one other compound (*e.g.*, activated carbon).

Carbon block technology where activated carbon is formed into a monolithic porous block with a binder is known. In U.S. Patent Nos. 4,753,728, 6,770,736, 7,049,382,

7,160,453, and 7,112,280, carbon block technology, using low melt flow polymer binders, are principally used as water filters.

Accordingly, there is a need for a porous mass having active particulates that can be used in a smoke filter, the smoke filter having an encapsulated pressure drop that is suitable for consumer use.

Summary of the Invention

The instant application is directed to a filter comprising a porous mass having an element that enhances the smoke flowing thereover. In some embodiments, the filter is incorporated within a smoking device.

In one embodiment, the present invention provides a filter comprising: a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device comprising: a housing for a smokeable substance; and a filter comprising a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device filter comprising: at least two neighboring in-series sections, wherein a first section comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; and wherein a second section comprises a section that comprises an element selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

In one embodiment, the present invention provides a smoking device comprising: a filter that comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any

combination thereof; and a housing capable of maintaining a smokeable substance in fluid contact with the filter.

In one embodiment, the present invention provides a pack of filters comprising: a pack comprising at least one filter, wherein the filter comprises a porous mass that comprises an active particle and a binder particle, and wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a pack of smoking devices comprising: a pack comprising at least one smoking device that comprises a filter that comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a carton of smoking device packs comprising: a carton comprising at least one pack, the pack comprising at least one smoking device that comprises a filter that comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene

aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a method of smoking a smoking device, the method comprising: heating or lighting a smoking device to form smoke, wherein the smoking device comprises at least one filter section comprising a porous mass that comprises an active particle and a binder particle, and wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass.

In one embodiment, the present invention provides a method of making a porous mass, the method comprising: providing a blend comprising active particles and a binder particles; wherein the binder particles comprise a thermoplastic and the active particles comprise an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an

endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; placing the blend in a mold; heating the blend in the mold to a temperature at or above the melting point of the binder particles so as to form a porous mass; and removing the porous mass from the mold.

In one embodiment, the present invention provides a method of making a porous mass, the method comprising: providing a blend comprising active particles and binder particles, wherein the binder particles comprise a thermoplastic and the active particles comprise an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; heating the blend; and extruding the blend while at an elevated temperature so as to form a porous mass.

In one embodiment, the present invention provides a method for making a filter rod, the method comprising: providing a first filter section; providing at least one second filter section, wherein the second filter section comprises a porous mass that comprises an active particle and a binder particle, and wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; and joining the first filter section and at least one second filter section so as to form a filter rod.

In one embodiment, the present invention provides a method comprising: providing a container that comprises at least a plurality of first filter section pieces; providing a second container comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprise a porous mass that comprises an active particle and a binder particle, and wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; joining a first filter section piece and a second filter section piece end-to-end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; and wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a filter rod comprising at least one filter section that comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two smoking device filters having at least one filter section that comprises a porous mass that comprises an active particle and a binder particle; and joining at

least one of the smoking device filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a tobacco column; joining a filter to the tobacco column, wherein the filter comprises a porous mass having an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides an apparatus comprising: a container area comprising at least a plurality of first filter section pieces; a second container area comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; a joiner area wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides a smoking device filter comprising: a filter section, the filter section comprising a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%.

In one embodiment, the present invention provides a smoking device comprising: a housing for a smokeable substance, and a filter comprising a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%.

In one embodiment, the present invention provides a smoking device filter comprising: at least two neighboring longitudinal in-series sections, wherein a first section comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%; and wherein a second section comprises a section that is selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

In one embodiment, the present invention provides a smoking device comprising: a filter that comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%; and a housing capable of maintaining a smokeable substance in fluid contact with the filter.

In one embodiment, the present invention provides a pack of filters comprising: a pack comprising at least one filter that comprises a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has a void volume of about 40% to about 90%.

In one embodiment, the present invention provides a pack of smoking devices comprising: a pack comprising at least one smoking device that comprises a filter that comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%.

In one embodiment, the present invention provides a smoking device carton comprising: a container comprising at least one pack that comprises at least one smoking device, wherein the smoking device comprises a filter that comprises a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has a void volume of about 40% to about 90%.

In one embodiment, the present invention provides a method of smoking a smoking device, the method comprising: heating or lighting a smoking device to form smoke, wherein the smoking device comprises at least one filter section comprising a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has a void volume of about 40% to about 90%; drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass.

In one embodiment, the present invention provides a method of making a filter, the method comprising: providing a blend comprising active particles and binder particles; placing the blend in a mold; heating the blend in the mold to a temperature at or above the melting point of the binder particles so as to form a porous mass, wherein the porous mass has a void volume of about 40% to about 90%; removing the porous mass from the mold; and forming a filter comprising the porous mass.

In one embodiment, the present invention provides a method of making a smoking device filter, the method comprising: providing a blend comprising active particles and binder particles; heating the blend; extruding the blend while at an elevated temperature so as to form a porous mass, wherein the porous mass has a void volume of about 40% to about 90%; and forming a filter comprising the porous mass.

In one embodiment, the present invention provides a method for making a smoking device, the method comprising: providing a first filter section; providing at least one second filter section, wherein the second filter section comprises a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has a void volume of about 40% to about 90%; joining the first filter section and at least one second filter section so as to form a filter rod; and joining at least a portion of the filter rod with a tobacco column to form a smoking device.

In one embodiment, the present invention provides a method of making a filter rod, the method comprising: providing a container that comprises at least a plurality of first filter

section pieces; providing a second container comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprise a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has a void volume of about 40% to about 90%; joining a first filter section piece and a second filter section piece end-to-end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; and wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a filter rod comprising at least one filter section that comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two smoking device filters having at least one filter section that comprises a porous mass that comprises an active particle and a binder particle; and joining at least one of the smoking device filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a tobacco column; joining a filter to the tobacco column, wherein the filter comprises a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has a void volume of about 40% to about 90%.

In one embodiment, the present invention provides an apparatus comprising: a container area comprising at least a plurality of first filter section pieces; a second container area comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has a void volume of about 40% to about 90%; a joiner area wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides a filter comprising: a porous mass that comprises an active particle and a binder particle, wherein the porous mass has an active

particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon.

In one embodiment, the present invention provides a smoking device comprising: a smokeable substance; and a filter comprising a porous mass that comprises an active particle and a binder particle, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device filter comprising: at least two neighboring longitudinal in-series filter sections, wherein a first filter section comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; and wherein a second filter section comprises a section that is selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

In one embodiment, the present invention provides a smoking device comprising: a filter that comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; and a housing capable of maintaining a smokeable substance in fluid contact with the filter.

In one embodiment, the present invention provides a pack of filters comprising: a pack comprising at least one filter, wherein the filter comprises a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a pack comprising: a container comprising at least one smoking device that comprises a filter, the filter comprising a porous

mass that comprises an active particle and a binder particle, and wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a carton of smoking device packs comprising: a container comprising at least one pack that comprises at least one smoking device that comprises a porous mass that comprises a filter that comprises an active particle and a binder particle, and wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a method of smoking a smoking device, the method comprising: heating or lighting a smoking device to form smoke, wherein the smoking device comprise at least one filter section comprising a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; and drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass.

In one embodiment, the present invention provides a method of making a filter, the method comprising: providing a blend comprising active particles and binder particles; placing the blend in a mold; heating the blend in the mold to a temperature at or above the melting point of the binder particle so as to form a porous mass, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; removing the porous mass from the mold; and forming a filter comprising the porous mass.

In one embodiment, the present invention provides a method of making a smoking device filter, the method comprising: providing a blend comprising active particles and binder particles; heating the blend; extruding the blend while at an elevated temperature so as to form a porous mass, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; and forming a filter comprising the porous mass.

In one embodiment, the present invention provides a method for producing a smoking device, the method comprising: providing a first filter section; providing at least one second

filter section, wherein the second filter section comprises a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; joining the first filter section and at least one second filter section so as to form a filter rod; and joining at least a portion of the filter rod with a tobacco column to form a smoking device.

In one embodiment, the present invention provides a method of making a filter rod, the method comprising: providing a container that comprises at least a plurality of first filter section pieces; providing a second container comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprise a porous mass that comprises an active particle and a binder particle, and wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; joining a first filter section piece and a second filter section piece end-to-end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod; and transporting the filter rod to a subsequent area for storage or use.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a filter rod comprising at least one filter section that comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two smoking device filters having at least one filter section that comprises a porous mass that comprises an active particle and a binder particle; and joining at least one of the smoking device filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a tobacco column; joining a filter to the tobacco column, wherein the filter comprises an active particle and a binder particle, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides an apparatus comprising: a container area comprising at least a plurality of first filter section pieces; a second container area comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprises a porous mass that comprises an active particle and a binder particle, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; a joiner area wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides a filter comprising: a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device comprising: a smokeable substance; and a filter comprising a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device filter comprising: at least two neighboring longitudinal in-series sections, wherein a first section comprises a porous mass that comprises an active particle and a binder particle; wherein the active particle is carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; and wherein a second section comprises a section that is selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

In one embodiment, the present invention provides a smoking device comprising: a filter that comprises a porous mass that has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; and a housing capable of maintaining a smokeable substance in fluid contact with the filter.

In one embodiment, the present invention provides a pack of filters comprising: a pack comprising at least one filter, the filter comprising a porous mass that has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a pack of smoking devices comprising: a pack comprising at least one smoking device that comprises a filter, wherein the filter comprises a porous mass that comprises an active particle and a binder particle, and wherein the active particle comprises carbon, and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a carton of smoking device packs comprising: a container comprising at least one pack that comprises at least one smoking device, the smoking device comprising a filter that comprises a porous mass, the porous mass comprising an active particle and a binder particle, and wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a method of smoking a smoking device, the method comprising: heating or lighting a smoking device to form smoke, wherein the smoking device comprises a smokeable substance and at least one filter section comprising a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises carbon, and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; drawing the smoke through the smoking device to form a smoke stream; and allowing the filter section to at least reduce the presence of at least one component in the smoke stream as compared to a filter without the porous mass.

In one embodiment, the present invention provides a method of making a filter, the method comprising: providing a blend comprising active particles and binder particles; placing the blend in a mold; heating the blend in the mold to a temperature at or above the

melting point of the binder particles so as to form a porous mass, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; removing the porous mass from the mold; and forming a filter comprising the porous mass.

In one embodiment, the present invention provides a method of making a smoking device filter, the method comprising: providing a blend comprising active particles and binder particles; heating the blend; extruding the blend while at an elevated temperature so as to form a porous mass, wherein the active particles comprise carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; forming a smoking device filter comprising the porous mass.

In one embodiment, the present invention provides a method for producing a smoking device, the method comprising: providing a first filter section; providing at least one second filter section, wherein the second filter section comprises a porous mass that has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; joining the first filter section and at least one second filter section longitudinally so as to form a filter rod; and joining at least a portion of the filter rod with a tobacco column to form a smoking device.

In one embodiment, the present invention provides a method of making a filter rod, the method comprising: providing a container that comprises at least a plurality of first filter section pieces; providing a second container comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprise a porous mass that has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; joining a first filter section piece and a second filter section piece end-to-end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; and wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a filter rod comprising at least one filter section that comprises a porous mass that has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis to form at

least two smoking device filters having at least one filter section that comprises a porous mass; and joining at least one of the smoking device filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In one embodiment, the present invention provides a method of making a smoking device, the method comprising: providing a tobacco column; and joining a filter to the tobacco column, the filter comprising having a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides an apparatus comprising: a container area comprising at least a plurality of first filter section pieces; a second container area comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprises a porous mass that comprises an active particle and a binder particle, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass; a joiner area wherein a first filter section piece and a second filter section piece are joined along their longitudinal axes; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides a compressible wrap surrounding the longitudinal axis of a porous mass filter section.

The features and advantages of the present invention will be readily apparent to one of ordinary skill in the art upon a reading of the description of the preferred embodiments that follows.

Description of the Drawings

For the purpose of illustrating the invention, there is shown in the drawings a form that is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Figure 1 is a cross-sectional view of an embodiment of a cigarette including a filter section according to the present invention.

Figure 2 is a cross-sectional view of another embodiment of a cigarette including a filter section according to the present invention.

Figure 3 is a cross-sectional view of another embodiment of a cigarette including a filter section according to the present invention.

Figure 4 is a cross-sectional view of a smoking device including a filter section according to the present invention.

Figure 5 is a photomicrograph of a section of an embodiment of a porous mass of the present invention.

Figure 6 is a comparative document that shows the results of encapsulated pressure drop testing for carbon-on-tow filters having an average circumference of about 24.5 mm.

Figure 7 shows the results of encapsulated pressure drop testing for porous mass filters of the present invention (comprising polyethylene and carbon) having an average circumference of about 24.5 mm.

Figure 8 is a comparative document that shows the results of encapsulated pressure drop testing for carbon-on-tow filters having an average circumference of about 16.9 mm.

Figure 9 shows the results of encapsulated pressure drop testing for porous mass filters of the present invention (comprising polyethylene and carbon) having an average circumference of about 16.9 mm.

Detailed Description of the Invention

The porous mass described hereinafter may be used with a smoking device, such as a tobacco smoking device. The porous mass includes active particles and non-fibrous binder particles and may form a portion of a filter section of a smoking device. The term "porous mass" as used herein refers to a mass comprising active particles and nonfibrous binder particles that form a structure bound by the binder particles and that includes void spaces therein, whereby smoke can travel through the porous mass and interact with the active particles. In some embodiments, the structure may be formed through the application of heat so that the binder particles soften to bind to the active particles at various contact points. While reference is made herein to "tobacco," it should be understood that the porous mass described herein is also suitable for use with other substances that produce smoke when burned or heated (*i.e.*, smokeable substances).

It should be noted that when "about" is provided below in reference to a number, the term "about" modifies each number of the numerical list. It should be noted that in some numerical listings of ranges, some lower limits listed may be greater than some upper limits listed. One skilled in the art will recognize that the selected subset will require the selection of an upper limit in excess of the selected lower limit.

Referring to Figures 1-4, there is shown several embodiments of a smoking device (these are representative, but not limiting on the smoking devices contemplated hereinafter). The term "smoking device," as used herein, most often refers to a cigarette, but it is not so limited and could be used with other smoking devices, such as cigarette holders, cigars, cigar holders, pipes, water pipes, hookahs, electronic smoking devices, roll-your-own cigarettes or cigars, etc. Hereinafter, reference will be to a cigarette as a generic term covering all of these smoking devices (unless otherwise specified).

In some embodiments, a smoking device may comprise a housing capable of maintaining a smokeable substance in fluid contact with the filter. Suitable housings may include, but are not limited to, a cigarette, a cigarette holder, a cigar, a cigar holder, a pipe, a water pipe, a hookah, an electronic smoking device, a roll-your-own cigarette, a roll-your-own cigar, and a paper.

In Figure 1, cigarette 10 includes a tobacco column 12 and a filter 14. Filter 14 may comprise at least two sections, first section 16 and second section 18. For example, the first

section 16 may comprise conventional filter material (discussed in greater detail below) and the second section 18 comprises a porous mass (discussed in greater detail below).

As used herein, the term "tobacco column" refers to the blend of tobacco, and optionally other ingredients and flavorants that may be combined to produce a tobacco-based smokeable article, such as a cigarette or cigar. In some embodiments, the tobacco column may comprise ingredients selected from the group consisting of: tobacco, sugar (such as sucrose, brown sugar, invert sugar, or high fructose corn syrup), propylene glycol, glycerol, cocoa, cocoa products, a carob bean gum, carob bean extracts, and any combination thereof. In still other embodiments, the tobacco column may further comprise flavorants, menthol, licorice extract, diammonium phosphate, ammonium hydroxide, and any combination thereof. Examples of suitable types of tobacco that may be used in the tobacco columns may include, but are not limited to, bright leaf tobacco, burley tobacco, Oriental tobacco (also known as Turkish tobacco), Cavendish tobacco, corojo tobacco, criollo tobacco, Perique tobacco, shade tobacco, white burley tobacco, and any combination thereof. The tobacco may be grown in the United States, or may be grown in a jurisdiction outside the United States.

In Figure 2, cigarette 20 has a tobacco column 12 and filter 22. Filter 22 is multi-segmented with three sections. In this embodiment, conventional filter materials 24 (or other alternative filter sections) may flank the porous mass 26.

In Figure 3, cigarette 30 has a tobacco column 12 and a filter 32. Filter 32 is multi-segmented with four sections. In this embodiment, end section 34 is a conventional material, but sections 36, 37, and 38 may be any combination of other filter materials and porous mass (so long as at least one of those sections is a porous mass of the present invention).

The foregoing embodiments are representative and not limiting. The inventive filters may have any number of sections, for example, 2, 3, 4, 5, 6, or more sections, and the sections may be placed in any suitable configuration. It is preferred that at least one of the filter sections comprise a porous mass of the present invention. Moreover, the sections may be the same as one another or different from one another.

Examples of sections that may incorporated with the porous masses of the present invention to form filters may include, but are not limited to, sections that comprise at least one element selected from the following: cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate,

random oriented acetate, papers, corrugated papers, concentric filters (*e.g.*, a peripheral filter of fibrous tow and a core of a web material), carbon-on-tow (sometimes referred to as a "Dalmatian filter"), silica, magnesium silicate, zeolites, molecular sieves, metallocenes, salts, catalysts, sodium chloride, nylon, flavorants, tobacco, capsules, cellulose, cellulosic derivatives, catalytic converters, iodine pentoxide, coarse powders, carbon particles, carbon fibers, fibers, glass beads, nanoparticles, void chambers (*e.g.*, formed by rigid elements, such as paper or plastic), baffled void chambers, and any combination thereof. If a zeolite is used, examples of suitable zeolites include, but are not limited to, BETA, SBA-15, MCM-41, MCM-48 modified by 3-aminopropylsilyl groups, and any combination thereof. In some embodiments, the filter may be substantially degradable over time (*e.g.*, over about 2 to about 5 years), either naturally or in the presence of a catalyst, that in some embodiments, may be present in a filter section itself. Also included are fibrous tows and papers with active materials (adhered thereto or impregnated therein or otherwise incorporated therewith). Such active materials include activated carbon (or charcoal), ion exchange resins, zeolites, desiccants, catalysts, or other materials adapted to affect the tobacco smoke. If used, void chambers may be filled (or partially filled) with active ingredients or materials incorporating the active ingredients. Such active ingredients include activated carbon (or charcoal), ion exchange resins, desiccants, or other materials adapted to affect the tobacco smoke. Additionally, the section may be a porous mass of binder particles (*i.e.*, binder particles alone without any active particles). For example, this porous mass without active particles may be made with thermoplastic particles (such as polyolefin powders, including the binder particles discussed below) that are bonded or molded together into a porous cylindrical shape.

In another embodiment, a section may comprise a space that defines a cavity between two filter sections (one section including a porous mass of the present invention). The cavity may be filled with granulated carbon, for example, or a flavorant, as another example. The cavity may contain a capsule, *e.g.*, a polymeric capsule, that itself contains a flavorant or catalyst. The cavity, in some embodiments, may also contain a molecular sieve that reacts with selected components in the smoke to remove or reduce the concentration of the components without adversely affecting desirable flavor constituents of the smoke. In an embodiment, the cavity may include tobacco as an additional flavorant. One should note that if the cavity is insufficiently filled with a chosen substance, in some embodiments, this may

create a lack of interaction between the components of the mainstream smoke and the substance in the cavity and in the other filter section(s).

Flavorants that may be suitable for use in the present invention include any flavorant suitable for use in smoking devices including those that to impart a taste and/or a flavor to the smoke stream. The flavorants may include, but not be limited to, organic material (or naturally flavored particles), carriers for natural flavors, carriers for artificial flavors, and any combination thereof. Organic materials (or naturally flavored particles) include, but are not limited to, tobacco, cloves (*e.g.*, ground cloves and clove flowers), cocoa, and the like. Natural and artificial flavors may include, but are not limited to, menthol, cloves, cherry, chocolate, orange, mint, mango, vanilla, cinnamon, tobacco, and the like. Such flavors may be provided by menthol, anethole (licorice), limonene (citrus), eugenol (clove), and the like. In some embodiments, more than one flavorant may be used including any combination of the flavorants provided herein. These flavorants may be placed in the tobacco column or in a section of a filter. Additionally, in some embodiments, the porous masses of the present invention may comprise a flavorant. The amount to include will depend on the desired level of flavor in the smoke taking into account all filter sections, the length of the smoking device, the type of smoking device, the diameter of the smoking device, as well as other factors known to those of skill in the art.

The sections that comprise a filter may be wrapped with paper to form filter rods. The term "paper" as used herein refers collectively to any wrapping papers that are used in the production of smoking devices, including tipping paper, plug wrap paper, tipping base paper, and the like. Suitable papers for use in conjunction with present invention include wood-based papers, papers containing flax, flax papers, functionalized papers (*e.g.*, those that are functionalized so as to reduce tar and/or carbon monoxide), special marking papers, colorized papers, and any combination thereof. In some embodiments, the papers may be high porosity, corrugated, and/or have a high surface strength. In some embodiments, the papers may comprise additives, sizing, and/or printability agents. In some embodiments, the filter rods that comprise a porous mass of the present invention may have lengths ranging from about 80 mm to about 150 mm. During processing, the filter rods may be subsequently split into about 4 or about 6 individual segments of about 5 to about 35 mm in length during a smoking device tipping operation. For dual or triple filters, the filters may be first cut into segments and combined with paper and/or charcoal segments prior to tipping. The filter rods

may be attached to tobacco column with paper or other smoking apparatus to produce a finished smoking device. By way of example, in traditional cigarette manufacturing, at least three papers are used: plug wrap, cigarette paper, and tipping paper. Plug wrap refers to the paper that is used to cover the filter section of the cigarette as that filter is produced and before it is joined to a tobacco column. Cigarette paper refers to the paper that is used to cover the tobacco column section of the cigarette as that tobacco column is produced and before it is joined to a filter section. Finally, tipping paper refers to the paper that is used to cover the filter section and a portion of the tobacco column as the two sections are joined to form a cigarette. The seams of the various papers used to form a cigarette are joined using at least one adhesive, and more than one type of adhesive may be used in the formation of the cigarette. By way of example, as a traditional cellulose acetate filter section is formed, a polyvinyl alcohol adhesive may be used to anchor the filter to the paper and a hot melt glue may be used at the edge of the paper to keep the filter wrapped. Also, cigarette paper may use a starch adhesive to join the edges of the paper. Finally tipping paper may be more fully coated, that is coated over most of the surface rather than only at the seam area, with a hot melt adhesive to ensure that the filter section and the tobacco section remain properly joined. In some cigarette products, ventilation holes are made through the tipping paper, or through both the tipping paper and the plug wrap in order to allow air to be drawn into the smoke stream.

In some embodiments, the filters may have a diameter in the range of about 5 mm to about 10 mm and a length of from about 5 mm to about 35 mm. In some embodiments, for example for ultra-slim or super-slim cigarettes, the filters may have a diameter in the range of less than 5 mm, for example, 3 mm or less, including, but not limited to, a lower diameter limit of 0.5 mm. For cigar embodiments, the filters may have a diameter larger than 20 mm, for example about 30 mm, as desired. Similarly, the size of the filter for other smoking devices may vary based on the intended use and consumer demand (*e.g.*, in a pipe).

In Figure 4, a pipe 40 has a burning bowl 42, a mouth piece 44, and a channel 46 interconnecting burning bowl 42 and mouth piece 44. Channel 46 includes a cavity 47. Cavity 47 is adapted for receipt of a filter 48. Filter 48 may be a multi-segmented filter as discussed above or may consist solely of the porous mass. The size of the filter may vary based on the dimensions of cavity 47. In some embodiments, filter 48 may be removable, replaceable, disposable, recyclable, and/or degradable.

In the foregoing embodiments, the conventional materials and porous mass are "joined." The term "joined," as used herein, means that the porous mass is in-line (or in series) neighboring a tobacco column or another filter section, so that when the cigarette is smoked, smoke from the tobacco column must pass through (*e.g.*, in series) the porous mass to arrive at its intended recipient (*e.g.*, a smoker). As noted above, the porous mass may be joined to the tobacco column through paper wrapping techniques, *e.g.*, using paper and/or an adhesive. Additionally, in some embodiments, the porous mass may be joined to the tobacco column using an adhesive, which preferably is free from components that, upon burning, would interfere with the purposes of the invention.

As shown in Figures 1-3, in some embodiments, a filter section comprising a porous mass and at least one other filter section may be co-axial, juxtaposed, abutting, and have equivalent cross-sectional areas (or substantially equivalent cross-sectional areas). But, it is understood that the porous mass and the conventional materials need not be joined in such a fashion, and that there may be other possible configurations. Moreover, while, it is envisioned that porous mass will be, most often, used in a combined or multi-segmented cigarette filter configuration, as shown in Figures 1-3; the invention is not so limited and a smoking device may comprise only a porous mass of the present invention, as discussed above with regard to Figure 4. Further, although in some embodiments, the porous mass will be juxtaposed to the tobacco column, as shown in Figure 1, the present disclosure is not so limited. For example, a porous mass of the present invention may be separated from the tobacco by a hollow cavity (*e.g.*, a tube, or channel, such as in a pipe or hookah or a cigarette or cigar holder), for example, see Figure 4. In other embodiments, a porous mass of the present invention may be separated from a tobacco column by a bendable element, allowing a consumer to shape the smoking device.

In some embodiments, the porous masses of the present invention comprise active particles that are at least partially bonded together with binder particles. For example, see Figure 5, a photomicrograph of an embodiment of the porous mass where active particles (*e.g.*, activated carbon particles) 50 and binder particles 52. Shown at 54 is an example of a point of contact. Note: in this embodiment (Figure 5), binder particles and active particles are joined at points of contact, the points of contact are randomly distributed throughout the porous mass, and the binder particles have retained their original physical shape (or substantially retained their original shape, *e.g.*, no more that 10% variation (*e.g.*, shrinkage)

in shape from original). (The active particles and the binder particles are discussed in greater detail below.) Although not wishing to be limited to any theory, it is believed that the points of contact form when the binder particles are heated to their softening temperature, but not hot enough to reach a true melt. In some embodiments, it is believed that the porous masses of the present invention are constructed so that they exhibit a minimal encapsulated pressure drop (defined below) while maximizing the active particles' surface area.

There may be any weight ratio of active particles to binder particles in the porous mass. In some embodiments, the ratio may be about 1 to about 99 weight % active particles and about 99 to about 1 weight % binder particles. In some embodiments, the ratio may be about 25 to about 99 weight % active particles and about 1 to about 75 weight % binder particles. In some embodiments, the ratio may be about 40 to about 99 weight % active particles and about 1 to about 60 weight % binder particles. In one embodiment of the porous mass, the active particles comprise about 50 to about 99 weight % of the mass while the binder particles comprise about 1 to about 50 weight % of the mass. In another embodiment, the active particles comprise about 60 to about 95 weight % of the mass while the binder particles comprise about 5 to about 40 weight % of the mass. Moreover, in yet another embodiment, the active particles comprise about 75 to about 90 weight % of the mass while the binder particles comprise about 10 to about 25 weight % of the mass.

In one embodiment of the porous mass, the porous mass has a void volume in the range of about 40% to about 90%. In another embodiment, it has a void volume of about 60% to about 90%. In yet another embodiment, it has a void volume of about 60% to about 85%. Void volume is the free space left after accounting for the space taken by the active particles.

To determine void volume, although not wishing to be limited by any particular theory, it is believed that testing indicates that the final density of the mixture was driven almost entirely by the active particle; thus the space occupied by the binder particles was not considered for this calculation. Thus, void volume, in this context, is calculated based on the space remaining after accounting for the active particles. To determine void volume, first the upper and lower diameters based on the mesh size were averaged for the active particles, and then the volume was calculated (assuming a spherical shape based on that averaged diameter) and using the density of the active material. Then, the percentage void volume is calculated as follows:

$$\text{Void Volume (\%)} = 1 - \frac{[(\text{porous mass volume, cm}^3) - (\text{Weight of active particles, gm})/(\text{density of the active particles, gm/cm}^3)] * 100}{\text{porous mass volume, cm}^3}$$

In one embodiment, the porous mass has an encapsulated pressure drop (EPD) in the range of about 0.10 to about 25 mm of water per mm length of porous mass. As used herein, the term "encapsulated pressure drop" refers to the static pressure difference between the two ends of a specimen when it is traversed by an air flow under steady conditions when the volume flow is 17.5 ml/sec at the output end when the specimen is completely encapsulated in a measuring device so that no air can pass through the wrapping. EPD has been measured herein under the CORESTA ("Cooperation Centre for Scientific Research Relative to Tobacco") Recommended Method No. 41, dated June 2007. In another embodiment, a porous mass of the present invention may have an EPD in the range of about 0.10 to about 10 mm of water per mm length of porous mass. In other embodiments, a porous mass of the present invention may have an EPD of about 2 to about 7 mm of water per mm length of porous mass (or no greater than 7 mm of water per mm length of porous mass). To obtain the desired EPD, the active particles must have a greater particle size than the binder particles. In one embodiment, the ratio of binder particle size to active particle size is in the range of about 1:1.5 to about 1:4.

In some embodiments, the porous mass of the present invention may have an active particle loading of at least about 1 mg/mm, 2 mg/mm, 3 mg/mm, 4 mg/mm, 5 mg/mm, 6 mg/mm, 7 mg/mm, 8 mg/mm, 9 mg/mm, 10 mg/mm, 11 mg/mm, 12 mg/mm, 13 mg/mm, 14 mg/mm, 15 mg/mm, 16 mg/mm, 17 mg/mm, 18 mg/mm, 19 mg/mm, 20 mg/mm, 21 mg/mm, 22 mg/mm, 23 mg/mm, 24 mg/mm, or 25 mg/mm in combination with an EPD of less than about 20 mm of water or less per mm of porous mass, 19 mm of water or less per mm of porous mass, 18 mm of water or less per mm of porous mass, 17 mm of water or less per mm of porous mass, 16 mm of water or less per mm of porous mass, 15 mm of water or less per mm of porous mass, 14 mm of water or less per mm of porous mass, 13 mm of water or less per mm of porous mass, 12 mm of water or less per mm of porous mass, 11 mm of water or less per mm of porous mass, 10 mm of water or less per mm of porous mass, 9 mm of water or less per mm of porous mass, 8 mm of water or less per mm of porous mass, 7 mm of water or less per mm of porous mass, 6 mm of water or less per mm of porous mass, 5 mm of water

or less per mm of porous mass, 4 mm of water or less per mm of porous mass, 3 mm of water or less per mm of porous mass, 2 mm of water or less per mm of porous mass, or 1 mm of water or less per mm of porous mass. By way of example, in some embodiments, the porous mass may have an active particle loading of at least about 1 mg/mm and an EPD of about 20 mm of water or less per mm of porous mass. In other embodiments, the porous mass may have an active particle loading of at least about 1 mg/mm and an EPD of about 20 mm of water or less per mm of porous mass, wherein the active particle is not carbon. In other embodiments, the porous mass may have an active particle comprising carbon with a loading of at least 6 mg/mm in combination with an EPD of 10 mm of water or less per mm of porous mass.

Depending on how the porous mass is made, the porous mass may have any desired length. In a batch molding process, for example, the length would likely match the dimension of the mold(s) used. Additionally, in a continuous production process, the porous mass may be one long continuous cylinder of any desired length. In either event, the porous mass could subsequently be cut into desired smaller lengths or sections. The desired length may depend on the particular application in which the porous mass may be used. In one embodiment, the porous mass may have a length of about 1 mm to about 35 mm. In another embodiment, the porous mass may have a length of about 2 mm to about 30 mm. In another, the porous mass may have a length of about 7 mm to about 20 mm.

The porous mass may have any physical shape. The porous mass may have a helical shape, a triangular shape, a disk shape, or a square shape, in some embodiments. In one embodiment, it is in the shape of a cylinder. A hybrid shape of these shapes may be suitable as well. In some embodiments, the porous mass may be machined to be lighter in weight, if desired, for example, by drilling out a portion of the porous mass. In one embodiment, the porous mass may have a specific shape for a cigarette holder or pipe that is adapted to fit within the cigarette holder or pipe to allow for smoke passage through the filter to the consumer. When discussing the shape of a porous mass herein, with respect to a traditional smoking device filter, the shape may be referred to in terms of diameter or circumference (wherein the circumference is the perimeter of a circle) of the cross section of the cylinder. But in embodiments where a porous mass of the present invention is in a shape other than a true cylinder, it should be understood that the term "perimeter" is used to mean the perimeter of any shaped cross-section, including a circular cross-section.

The active particles may be any material adapted to enhance smoke flowing thereover. Adapted to enhance smoke flowing thereover refers to any material that can remove, reduce, or add components to a smoke stream. The removal or reduction (or addition) may be selective. By way of example, in the smoke stream from a cigarette, compounds such as those shown below in the following listing may be selectively removed or reduced. This table is available from the U.S. FDA as a Draft Proposed Initial List of Harmful/Potentially Harmful Constituents in Tobacco Products, including Tobacco Smoke; any abbreviations in the below listing are well-known chemicals in the art. In some embodiments, the active particle may reduce or remove at least one component selected from the listing of components in smoke below, including any combination thereof.

Acetaldehyde
Acetamide
Acetone
Acrolein
Acrylamide
Acrylonitrile
Aflatoxin B-1
4-Aminobiphenyl
1-Aminonaphthalene
2-Aminonaphthalene
Ammonia
Ammonium Salts
Anabasine
Anatabine
0-Anisidine
Arsenic
A-α-C
Benz[a]anthracene
Benz[b]fluoroanthene
Benz[j]aceanthrylene
Benz[k]fluoroanthene
Benzene
Benzo(b)furan
Benzo[a]pyrene
Benzo[c]phenanthrene
Beryllium
1,3-Butadiene
Butyraldehyde
Cadmium
Caffeic acid
Carbon monoxide
Catechol
Chlorinated dioxins/furans
Chromium
Chrysene
Cobalt
Coumarin
Cresols
Crotonaldehyde
Cyclopenta[c,d]pyrene
Dibenz(a,h)acridine
Dibenz(a,j)acridine

Dibenz[a,h]anthracene
Dibenzo(c,g)carbazole
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Dibenzo[a,l]pyrene
2,6-Dimethylaniline
Ethyl Carbamate (urethane)
Ethylbenzene
Ethylene oxide
Eugenol
Formaldehyde
Furan
Glu-P-1
Glu-P-2
Hydrazine
Hydrogen cyanide
Hydroquinone
Indeno[1,2,3-cd]pyrene
IQ
Isoprene
Lead
MeA- α-C
Mercury
Methyl ethyl ketone
5-Methylchrysene
4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK)
4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL)
Naphthalene
Nickel
Nicotine
Nitrate
Nitric oxide/nitrogen oxides
Nitrite
Nitrobenzene
Nitromethane
2-Nitropropane
N-nitrosoanabasine (NAB)

N-Nitrosodiethanolamine (NDELA)
N-Nitrosodiethylamine
N-nitrosodimethylamine (NDMA)
N-Nitrosoethylmethylamine
N-nitrosomorpholine (NMOR)
N-nitrosonornicotine (NNN)
N-Nitrosopiperidine (NPIP)
N-nitrosopyrrolidine (NPYR)
N-nitrososarcosine (NSAR)
Phenol
PhIP
Polonium-210 (Radio-isotope)
Propionaldehyde
Propylene oxide
Pyridine
Quinoline
Resorcinol
Selenium
Styrene
Tar
2-Toluidine
Toluene
Trp-P-1
Trp-P-2
Uranium-235 (Radio-isotope)
Uranium-238 (Radio-isotope)
Vinyl Acetate
Vinyl Chloride

One example of an active material is activated carbon (or activated charcoal or active coal). The activated carbon may be low activity (about 50% to about 75% CCl_4 adsorption) or high activity (about 75% to about 95% CCl_4 adsorption) or a combination of both. In some embodiments, the active carbon may be nano-scaled carbon particle, such as carbon nanotubes of any number of walls, carbon nanohorns, bamboo-like carbon nanostructures, fullerenes and fullerene aggregates, and graphene including few layer graphene and oxidized graphene. Other examples of such materials include ion exchange resins, desiccants, silicates, molecular sieves, metallocenes, silica gels, metallocene, activated alumina, zeolites, perlite, sepiolite, Fuller's Earth, magnesium silicate, metal oxides (*e.g.*, iron oxide and iron oxide nanoparticles like about 12 nm Fe_3O_4), nanoparticles (*e.g.*, metal nanoparticles like gold and silver; metal oxide nanoparticles like alumina; magnetic, paramagnetic, and superparamagentic nanoparticles like gadolinium oxide, various crystal structures of iron oxide like hematite and magnetite, gado-nanotubes, and endofullerenes like $Gd@C_{60}$; and core-shell and onionated nanoparticles like gold and silver nanoshells, onionated iron oxide, and others nanoparticles or microparticles with an outer shell of any of said materials) and any combination of the foregoing (including activated carbon). It should be noted that nanoparticles include nanorods, nanospheres, nanorices, nanowires, nanostars (like nanotripods and nanotetrapods), hollow nanostructures, hybrid nanostructures that are two or more nanoparticles connected as one, and non-nano particles with nano-coatings or nano-thick walls. It should be further noted that nanoparticles include the functionalized derivatives of nanoparticles including, but not limited to, nanoparticles that have been functionalized covalently and/or non-covalently, *e.g.*, pi-stacking, physisorption, ionic association, van der Waals association, and the like. Suitable functional groups may include, but not be limited to, moieties comprising amines (1^o, 2^o, or 3^o), amides, carboxylic acids, aldehydes, ketones, ethers, esters, peroxides, silyls, organosilanes, hydrocarbons, aromatic hydrocarbons, and any combination thereof; polymers; chelating agents like ethylenediamine tetraacetate, diethylenetriaminepentaacetic acid, triglycollamic acid, and a structure comprising a pyrrole ring; and any combination thereof. Functional groups may enhance removal of smoke components and/or enhance incorporation of nanoparticles into a porous mass. Ion exchange resins include, for example, a polymer with a backbone, such as styrene-divinyl benzene (DVB) copolymer, acrylates, methacrylates, phenol formaldehyde

condensates, and epichlorohydrin amine condensates; and a plurality of electrically charged functional groups attached to the polymer backbone. In some embodiments, the active particles are a combination of various active particles. In some embodiments, the porous mass may comprise multiple active particles. In some embodiments, an active particle may comprise at least one element selected from the group of active particles disclosed herein. It should be noted that "element" is being used as a general term to describe items in a list. In some embodiments, the active particles are combined with at least one flavorant.

In some embodiments, a mixture of active particles may be used to remove multiple harmful substances from a smoke stream. For example, while activated charcoal has been shown to be successful in removing substances such as formaldehyde and acetone from cigarette smoke, it is ineffective in removing carbon monoxide. However, carbon monoxide may be removed from a gaseous stream by exposure to iodine pentoxide, a molecular sieve (such as a metallocene), a molecular oxide, a metal catalyst (such as palladium), and the like.

In one embodiment, the active particles have a particle sizes ranging from particles having at least one dimension of about less than one nanometer, such as graphene, to as large as a particle having a diameter of about 5000 microns. The active particles may range from a lower size limit in at least one dimension of about: 0.1 nanometers, 0.5 nanometers, 1 nanometer, 10 nanometers, 100 nanometers, 500 nanometers, 1 micron, 5 microns, 10 microns, 50 microns, 100 microns, 150 microns, 200 microns, and 250 microns. The active particles may range from an upper size limit in at least one dimension of about: 5000 microns, 2000 microns, 1000 microns, 900 microns, 700 microns, 500 microns, 400 microns, 300 microns, 250 microns, 200 microns, 150 microns, 100 microns, 50 microns, 10 microns, and 500 nanometers. Any combination of lower limits and upper limits above may be suitable for use in the present invention, wherein the selected maximum size is greater than the selected minimum size. In some embodiments, the active particles may be a mixture of particle sizes ranging from the above lower and upper limits.

The binder particles may be any suitable thermoplastic binder particles. In one embodiment, the binder particles exhibit virtually no flow at its melting temperature. This means a material that when heated to its melting temperature exhibits little to no polymer flow. Materials meeting these criteria include, but are not limited to, ultrahigh molecular weight polyethylene, very high molecular weight polyethylene, high molecular weight polyethylene, and combinations thereof. In one embodiment, the binder particles have a melt

flow index (MFI, ASTM D1238) of less than or equal to about 3.5 g/10min at 190°C and 15 Kg (or about 0-3.5 g/10min at 190°C and 15 Kg). In another embodiment, the binder particles have a melt flow index (MFI) of less than or equal to about 2.0 g/10min at 190°C and 15 Kg (or about 0-2.0 g/10min at 190°C and 15 Kg). One example of such a material is ultra high molecular weight polyethylene, UHMWPE (which has no polymer flow, MFI of about 0, at 190°C and 15 Kg, or an MFI of about 0-1.0 at 190°C and 15 Kg); another material may be very high molecular weight polyethylene, VHMWPE (which may have MFIs in the range of, for example, about 1.0-2.0 g/10min at 190°C and 15 Kg); or high molecular weight polyethylene, HMWPE (which may have MFIs of, for example, about 2.0-3.5 g/10min at 190°C and 15 Kg). In some embodiments, it may be preferable to use a mixture of binder particles having different molecular weights and/or different melt flow indexes.

In terms of molecular weight, "ultra-high molecular weight polyethylene" as used herein refers to polyethylene compositions with weight-average molecular weight of at least about 3×10^6 g/mol. In some embodiments, the molecular weight of the ultra-high molecular weight polyethylene composition is between about 3×10^6 g/mol and about 30×10^6 g/mol, or between about 3×10^6 g/mol and about 20×10^6 g/mol, or between about 3×10^6 g/mol and about 10×10^6 g/mol, or between about 3×10^6 g/mol and about 6×10^6 g/mol. "Very-high molecular weight polyethylene" refers to polyethylene compositions with a weight average molecular weight of less than about 3×10^6 g/mol and more than about 1×10^6 g/mol. In some embodiments, the molecular weight of the very-high molecular weight polyethylene composition is between about 2×10^6 g/mol and less than about 3×10^6 g/mol. "High molecular weight polyethylene" refers to polyethylene compositions with weight-average molecular weight of at least about 3×10^5 g/mol to 1×10^6 g/mol. For purposes of the present specification, the molecular weights referenced herein are determined in accordance with the Margolies equation ("Margolies molecular weight").

Suitable polyethylene materials are commercially available from several sources including GUR® UHMWPE from Ticona Polymers LLC, a division of Celanese Corporation of Dallas, TX, and DSM (Netherland), Braskem (Brazil), Beijing Factory No. 2 (BAAF), Shanghai Chemical, and Qilu (People's Republic of China), Mitsui and Asahi (Japan). Specifically, GUR® polymers may include: GUR® 2000 series (2105, 2122, 2122-5, 2126), GUR® 4000 series (4120, 4130, 4150, 4170, 4012, 4122-5, 4022-6, 4050-3/4150-3), GUR® 8000 series (8110, 8020), GUR® X series (X143, X184, X168, X172, X192).

One example of a suitable polyethylene material is that having an intrinsic viscosity in the range of about 5 dl/g to about 30 dl/g and a degree of crystallinity of about 80% or more as described in U.S. Patent Application Publication No. 2008/0090081. Another example of a suitable polyethylene material is that having a molecular weight in the range of about 300,000 g/mol to about 2,000,000 g/mol as determined by ASTM-D 4020, an average particle size, D_{50}, between about 300 μm and about 1500 μm, and a bulk density between about 0.25 g/ml and about 0.5 g/ml as described in U.S. Provisional Application No. 61/330,535 filed May 3, 2010.

The binder particles may assume any shape. Such shapes include spherical, hyperion, asteroidal, chrondular, or interplanetary dust-like, granulated, potato, irregular, or combinations thereof. In preferred embodiments, the binder particles suitable for use in the present invention are non-fibrous. In some embodiments the binder particles are in the form of a powder, pellet, or particulate. In some embodiments, the binder particles are a combination of various binder particles.

In some embodiments, the binder particles may range from a lower size limit in at least one dimension of about: 0.1 nanometers, 0.5 nanometers, 1 nanometer, 10 nanometers, 100 nanometers, 500 nanometers, 1 micron, 5 microns, 10 microns, 50 microns, 100 microns, 150 microns, 200 microns, and 250 microns. The binder particles may range from an upper size limit in at least one dimension of about: 5000 microns, 2000 microns, 1000 microns, 900 microns, 700 microns, 500 microns, 400 microns, 300 microns, 250 microns, 200 microns, 150 microns, 100 microns, 50 microns, 10 microns, and 500 nanometers. Any combination of lower limits and upper limits above may be suitable for use in the present invention, wherein the selected maximum size is greater than the selected minimum size. In some embodiments, the binder particles may be a mixture of particle sizes ranging from the above lower and upper limits.

Additionally, the binder particles may have a bulk density in the range of about 0.10 g/cm^3 to about 0.55 g/cm^3. In another embodiment, the bulk density may be in the range of about 0.17 g/cm^3 to about 0.50 g/cm^3. In yet another embodiment, the bulk density may be in the range of about 0.20 g/cm^3 to about 0.47 g/cm^3.

In addition to the foregoing binder particles, other conventional thermoplastics may be used as binder particles. Such thermoplastics include, but are not limited to, polyolefins, polyesters, polyamides (or nylons), polyacrylics, polystyrenes, polyvinyls,

polytetrafluoroethylene (PTFE), polyether ether ketone (PEEK), any copolymer thereof, any derivative thereof, and any combination thereof. Non-fibrous plasticized cellulose derivatives may also be suitable for use as binder particles in the present invention. Examples of suitable polyolefins include, but are not limited to, polyethylene, polypropylene, polybutylene, polymethylpentene, any copolymer thereof, any derivative thereof, any combination thereof and the like. Examples of suitable polyethylenes further include low-density polyethylene, linear low-density polyethylene, high-density polyethylene, any copolymer thereof, any derivative thereof, any combination thereof and the like. Examples of suitable polyesters include polyethylene terephthalate, polybutylene terephthalate, polycyclohexylene dimethylene terephthalate, polytrimethylene terephthalate, any copolymer thereof, any derivative thereof, any combination thereof and the like. Examples of suitable polyacrylics include, but are not limited to, polymethyl methacrylate, any copolymer thereof, any derivative thereof, any combination thereof and the like. Examples of suitable polystyrenes include, but are not limited to, polystyrene, acrylonitrile-butadiene-styrene, styrene-acrylonitrile, styrene-butadiene, styrene-maleic anhydride, any copolymer thereof, any derivative thereof, any combination thereof and the like. Examples of suitable polyvinyls include, but are not limited to, ethylene vinyl acetate, ethylene vinyl alcohol, polyvinyl chloride, any copolymer thereof, any derivative thereof, any combination thereof and the like. Examples of suitable cellulosics include, but are not limited to, cellulose acetate, cellulose acetate butyrate, plasticized cellulosics, cellulose propionate, ethyl cellulose, any copolymer thereof, any derivative thereof, any combination thereof and the like. In some embodiments, a binder particle may be any copolymer, any derivative, and any combination of the above listed binders.

The porous mass is effective at the removal of components from smoke, for example, those in the listing above. A porous mass can be used to reduce the delivery of certain tobacco smoke components targeted by the WHO. For example, a porous mass where activated carbon is used as the active particles can be used to reduce the delivery of certain tobacco smoke components to levels below the WHO recommendations. (See Table 13, below.) In one embodiment, the porous mass, where activated carbon is used, has a length in the range of about 4 mm to about 11 mm. The components include: acetaldehyde, acrolein, benzene, benzo[a]pyrene, 1,3-butadiene, and formaldehyde. The porous mass with activated carbon may reduce acetaldehydes in a smoke stream by about 3.0% to about 6.5%/mm length

of porous mass; acrolein in a smoke stream by about 7.5% to about 12%/mm length of porous mass; benzene in a smoke stream by about 5.5% to about 8.0%/mm length of porous mass; benzo[a]pyrene in a smoke stream by about 9.0% to about 21.0%/mm length of porous mass; 1,3-butadiene in a smoke stream by about 1.5% to about 3.5%/mm length of porous mass; and formaldehyde in a smoke stream by about 9.0% to about 11.0%/mm length of porous mass. In another example, a porous mass where an ion exchange resin is used as the active particles can be used to reduce the delivery of certain tobacco smoke components to below the WHO recommendations. See Table 14, below. In one embodiment, the porous mass, where ion exchange resins are used, has a length in the range of about 7 mm to about 1 mm. The components include: acetaldehyde, acrolein, and formaldehyde. In some embodiments, a porous mass of the present invention having an ion exchange resin may reduce: acetaldehydes in a smoke stream by about 5.0% to about 7.0%/mm length of porous mass; acrolein in a smoke stream by about 4.0% to about 6.5%/mm length of porous mass; and formaldehyde in a smoke stream by about 9.0% to about 11.0%/mm length of porous mass.

The porous mass may be made by any suitable means. In some embodiments, this may be a batch process. In others, this may be a continuous process.

In one embodiment of a suitable method, the active particles and binder particles are blended together and introduced into a mold. The mold is heated to a temperature at or above the melting point of the binder particles, *e.g.*, in one embodiment about 150°C to 300°C and held at the temperature for a period of time sufficient to heat the mold and its contents to the desired temperature. Thereafter, the mass is removed from the mold and cooled to room temperature. These methods may be done in small batches or large batches that may be suitable for commercial production.

In some embodiments, a suitable process may be a free sintering process, because the binder particles do not flow (or flow very little) at the sintering temperature and no pressure is applied to the blended materials in the mold. In this embodiment, point bonds are formed between the active particles and the binder particles. This is believed to enable the formation of superior bonding and maximizing the interstitial space, while minimizing the blinding of the surface of the active particles by free flowing molten binder. Also see, U.S. Patents 6,770,736, 7,049,382, and 7,160,453, incorporated herein by reference.

Alternatively, a porous mass of the present invention may be made by a process involving sintering under pressure. As the mixture of the active particles and the binder

particles are heated (or at a temperature which may be below, at, or above the melting temperature of the binder particles) a pressure is exerted on the mixture to facilitate coalescence of the porous mass.

Also, in some embodiments, the porous mass may be made by an extrusion sintering process where the mixture is heated in an extruder barrel and extruded into the porous mass.

Any suitable method for forming a smoking device filter comprising a porous mass of the present invention may be used in conjunction with the porous masses. For example, in one embodiment, an apparatus for producing a smoking device filter may be used that has at least a plurality of areas comprising: a container area comprising at least a plurality of first filter section pieces; a second container area comprising at least a plurality of second filter section pieces, the second filter section pieces comprising a porous mass having an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; a joiner area wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use. In some embodiments, a filter rod may be formed in this process that comprises a plurality of filters that when cut can be used to form multiple smoking devices (*e.g.*, 4 cigarettes per 1 filter rod).

In some embodiments, the smoking device filters may be directly transported to a manufacturing line whereby they will be combined with tobacco columns to form smoking devices. An example of such a method includes a process for producing a smoking device comprising: providing a filter rod comprising at least one filter section comprising a porous mass that comprises an active particle and a binder particle; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two filters having at least one filter section, each filter section comprising a porous mass that comprises an active particle and a binder particle; and joining at least one of the filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In traditional cigarette manufacturing, the machines that join the filter section to the tobacco column, as well as the machines that join together the section of the multi-component filter, tend to compress the sections of the cigarette as they progress through the joining

process. In some embodiments, the porous mass of the present invention may be non-compressible or less compressible than a traditional cellulose acetate filter section, which may lead to difficulty in some manufacturing processes. In embodiments where ultra high molecular weight polymers, such as ultra high molecular weight polyethylene, are used the porous mass of the present invention tends to be incompressible. In such cases, it may be desirable to wrap or encase the porous mass section with a material that is compressible. The wrapping or encasing material is placed along the longitudinal axis of the porous mass filter section such that the wrapping or encasing material is between the porous mass and the plug wrap paper. The wrapping or encasing material should be selected such that it provides the desired compressibility while also exhibiting a relatively high pressure drop such that smoke drawn through the section preferentially travels through the porous mass rather than the wrapping or encasing material or encasing material is greater than the encapsulated pressure drop of the porous mass. In some embodiments, the wrapping material may have an encapsulated pressure drop that is 1% higher than the encapsulated pressure drop of the porous mass, in other embodiments the difference may be 5% higher, 10% higher, 25% higher, 50% higher, 75% higher, 100% higher, 125% higher, 150% higher, 175% higher, 200% higher, 225% higher, 250% higher, 275% higher, or 300% higher. One of skill in the art will recognize that the difference in the encapsulated pressure drop between the wrapping or encasing material and the porous mass may go even higher so long as the user is not negatively effected and so long as the wrapping or encasing material continues to provide the desired compressibility. In some embodiments, the wrapping or encasing material may comprise cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and any combination thereof. IN other embodiments, the wrapping or encasing material is placed along the longitudinal axis of the porous mass filter section such that the wrapping or encasing material is on the outside of the plug wrap paper. One skilled will recognize that the porous mass diameter must be selected to compensate for the diameter increase as layer of papers or wrappings or encasing materials are added. The final filter diameter must match the tobacco column diameter for the filter/tobacco column combine step. In other embodiments, the wrapping or encasing material is placed along the longitudinal axis of the porous mass filter section such that the wrapping or encasing material is in direct contact with

the porous mass. This configuration can eliminate paper use in the sintering process. In other embodiments, the smoking device filters may be placed in a suitable container for storage until further use. Suitable storage containers include those commonly used in the smoking device filter art including, but not limited to crates boxes, drums, bags, cartons, and the like. Storage and transportation containers used with the porous mass filter sections of the present invention may need to be altered to account for presence of the porous mass. By way of example, cylindrical and other shaped rods or cigarettes incorporating porous mass filter sections of the present invention may be heavier in weight, or more brittle than a cellulose acetate filter section. In addition, due to the active nature of the porous mass, it may be desirable to ship porous mass sections or cigarettes incorporating porous mass sections such that the porous mass is not exposed to environmental contamination.

In some embodiments, a method of making a filter may comprise: providing a blend comprising active particles and binder particles; placing the blend in a mold; heating the blend in the mold to a temperature at or above the melting point of the binder particles so as to form a porous mass selected from at least one porous mass of the present invention; removing the porous mass from the mold; and forming a filter comprising the porous mass.

In some embodiments, a method of making a smoking device filter may comprise: providing a blend comprising an active particle and a binder particle; heating the blend; extruding the blend while at an elevated temperature so as to form a porous mass selected from at least one porous mass of the present invention; and forming a filter comprising the porous mass.

In some embodiments, a method for producing a smoking device may comprise: providing a first filter section; providing at least one second filter section, wherein the second filter section comprises a porous mass selected from at least one porous mass of the present invention; joining the first filter section and at least one second filter section so as to form a filter rod; and joining at least a portion of the filter rod with a tobacco column to form a smoking device.

In some embodiments, a method of making a filter rod may comprise: providing a container that comprises at least a plurality of first filter section pieces; providing a second container comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprise a porous mass selected from at least one porous mass of the present invention; joining a first filter section piece and a second filter section piece end-to-

end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod; and transporting the filter rod to a subsequent area for storage or use.

In some embodiments, a method of making a smoking device may comprise: providing a filter rod comprising at least one filter section that comprises a porous mass selected from at least one porous mass of the present invention; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two smoking device filters having at least one filter section that comprises a porous mass that comprises an active particle and a binder particle; and joining at least one of the smoking device filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In some embodiments, a method of making a smoking device may comprise: providing a tobacco column; joining a filter to the tobacco column, wherein the filter comprises a porous mass selected from at least one porous mass of the present invention.

An apparatus comprising: a container area comprising at least a plurality of first filter section pieces; a second container area comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprises a porous mass selected from at least one porous mass of the present invention; a joiner area wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In some embodiments, the present invention provides a pack of filters that comprises a porous mass of the present invention. The pack may be a hinge-lid pack, a slide-and-shell pack, a hard cup pack, a soft cup pack, or any other suitable pack container. In one embodiment, the present invention provides a pack comprising a pack and at least one filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass. In one embodiment, the present invention provides a pack comprising a pack and at least one filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least

about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass. In some embodiments, the packs may have an outer wrapping, such as a polypropylene wrapper, and optionally a tear tab. In some embodiments, the filters may be sealed as a bundle inside a pack. A bundle may contain a number of filters, for example, 20 or more. However, a bundle may include a single filter, in some embodiments, such as exclusive filter embodiments like those for individual sale, or a filter comprising a specific spice, like vanilla, clove, or cinnamon.

In some embodiments, the present invention provides a pack of smoking devices that includes at least one smoking device having a filter that comprises a porous mass of the present invention. The pack may be a hinge-lid pack, a slide-and-shell pack, a hard cup pack, a soft cup pack, or any other suitable pack container. In one embodiment, the present invention provides a cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass. In one embodiment, the present invention provides a cigar pack comprising a pack and at least one cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass. In some embodiments, the packs may have an outer wrapping, such as a polypropylene wrapper, and optionally a tear tab. In some embodiments, the smoking devices may be sealed as a bundle inside a pack. A bundle may contain a number of smoking devices, for example, 20 or more. However, a bundle may include a single smoking device, in some embodiments, such as exclusive smoking embodiments like a cigar, or a smoking device comprising a specific spice, like vanilla, clove, or cinnamon.

In some embodiments, the present invention provides a carton of smoking device packs that includes at least one pack of smoking devices that includes at least one smoking device having a porous mass of the present invention. For example, in one embodiment, the present invention provides a cigarette carton, the cigarette carton comprising at least one cigarette pack, the cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least

about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass. In some embodiments, the carton (*e.g.*, a container) has the physical integrity to contain the weight from the packs of cigarettes. This may be accomplished through thicker cardstock being used to form the carton or stronger adhesives being used to bind elements of the carton.

Because it is expected that a consumer will smoke a smoking device that includes a porous mass as described herein, the present invention also provides methods of smoking such a smoking device. For example, in one embodiment, the present invention provides a method of smoking a smoking device comprising: heating or lighting a smoking device to form smoke, the smoking device comprising at least one filter section having a porous mass having an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; and drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass. In some embodiments, the smoking device is a cigarette. In other embodiments, the smoking device is a cigar, a cigar holder, a pipe, a water pipe, a hookah, an electronic smoking device, a smokeless smoking device, a roll-your-own cigarette, a roll-your-own cigar, or another smoking device.

In one embodiment, a smoking device is provided that comprises a porous mass of active particles adapted to enhance a tobacco smoke flowing over said active particles and binder particles. The active particles comprise about 1% to about 99% weight of the porous mass, and the binder particles comprise about 1% to about 99% weight of said porous mass. The active particles and said binder particles are bound together at randomly distributed points throughout the porous mass. The active particles have a greater particle size than the binder particles.

In another embodiment, the present invention provides a filter comprising a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, a iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide

nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a filter comprising a porous mass that comprises an active particle and a binder particle, the porous mass having a carbon loading of at least about 6 mg/mm, and an encapsulated pressure drop ("EPD") of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a filter comprising a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm and an EPD of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon.

In one embodiment, the present invention provides a method of making a tobacco smoke filter for a smoking device comprising mixing binder particles and active particles so as to produce a porous mass having an active particle loading of at least about 1 mg/mm and an EPD of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon.

In one embodiment, the present invention provides a method of making a tobacco smoke filter for a smoking device comprising the steps of: mixing binder particles and active particles, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a method of making a tobacco smoke filter for a smoking device comprising mixing binder particles and active particles so as to produce a porous mass having a carbon loading of at least about 6 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device filter having at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device filter having at least one filter section having a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device filter having at least one filter section having a porous mass that comprises carbon and a binder particle, the porous mass having a carbon loading of at least about 6 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device comprising a filter that comprises at least one filter section having a porous mass, the porous mass having an active particle and a binder particle, the porous mass having: and an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device comprising a filter that comprises at least one filter section having a porous mass, the porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic

nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device comprising a filter that comprises at least one filter section having a porous mass, the porous mass having a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a method of making a cigarette, comprising: providing a tobacco column; attaching a filter to the tobacco column, the filter comprising a section that comprises a porous mass having an active particle and a binder particle, the porous mass having: active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon; and forming a cigarette.

In one embodiment, the present invention provides a smoking device that comprises a filter that comprises an active particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device that comprises a tobacco column that comprises tobacco and optionally an element selected from the group consisting of: sugar, sucrose, brown sugar, invert sugar, high fructose corn syrup, propylene glycol, glycerol, cocoa, a cocoa product, a carob bean gum, a carob bean extract, and any combination thereof, and a filter that comprises an active particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon

nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device that comprises a tobacco column that comprises tobacco and optionally an element selected from the group consisting of: sugar, sucrose, brown sugar, invert sugar, high fructose corn syrup, propylene glycol, glycerol, cocoa, a cocoa product, a carob bean gum, a carob bean extract, a flavorant, menthol, licorice extract, diammonium phosphate, ammonium hydroxide, and any combination thereof, and a filter that comprises an active particle, the active particle comprising a element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device that comprises a tobacco column that comprises a tobacco source selected from the group consisting of bright leaf tobacco, burley tobacco, Oriental tobacco, Cavendish tobacco, corojo tobacco, criollo tobacco, Perique tobacco, shade tobacco, white burley tobacco, and any combination thereof, and optionally an element selected from the group consisting of: sugar, sucrose, brown sugar, invert sugar, high fructose corn syrup, propylene glycol, glycerol, cocoa, a cocoa product, a carob bean gum, a carob bean extract, a flavorant, menthol, licorice extract, diammonium phosphate, ammonium hydroxide, and any combination thereof, and a filter that comprises an active particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one

wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a method of making a cigarette comprising: providing a tobacco column; attaching a filter to the tobacco column, the filter comprising a section that comprises a porous mass, the porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a method of making a cigarette, comprising: providing a tobacco column; attaching a filter to the tobacco column, the filter comprising a section that comprises a porous mass, the porous mass having a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a method of making a cigar, comprising: providing a tobacco column, attaching a filter to the tobacco column, the filter comprising a section that comprises a porous mass having an active particle and a binder particle, the porous mass having: active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a method of making a cigar comprising: providing a tobacco column; attaching a filter to the tobacco column, the filter comprising a section that comprises a porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; and forming a cigar.

In one embodiment, the present invention provides a method of making a cigar comprising: providing a tobacco column; attaching a filter to the tobacco column, the filter comprising a section that comprises a porous mass that comprises activated carbon and a binder particle, the porous mass having a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass; and forming a cigar.

In one embodiment, the present invention provides a cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon.

In one embodiment, the present invention provides a cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a

gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a cigar pack comprising a pack and at least one cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a cigar pack comprising a pack and at least one cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a cigarette carton, the cigarette carton comprising at least one cigarette pack, the cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous

mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon.

In one embodiment, the present invention provides a cigarette carton, the cigarette carton comprising at least one cigarette pack, the cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a cigarette carton, the cigarette carton comprising at least one cigarette pack, the cigarette pack comprising a pack and at least one cigarette comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a cigar carton, the cigar carton comprising at least one cigar pack, the cigar pack comprising a pack and at least one cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a cigar carton, the cigar carton comprising at least one cigar pack, the cigar pack comprising a pack and at least one cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the active particle comprising a element

selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a cigar carton, the cigar carton comprising at least one cigar pack, the cigar pack comprising a pack and at least one cigar comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the porous mass having: a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a method of making a smoking device filter, comprising incorporating into the smoking device filter a filter that comprises at least one filter section having a porous mass having an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass, and wherein the active particle is not carbon.

In one embodiment, the present invention provides a method of making a smoking device filter, comprising incorporating into the smoking device filter a filter that comprises at least one filter section having a porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an

onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a method of making a smoking device filter comprising: incorporating into the smoking device filter a filter that comprises at least one filter section having a porous mass having an active particle and a binder particle, the porous mass having: a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a process for producing a smoking device filter comprising: providing a first filter section, providing at least a second filter section, the second filter section having a porous mass having an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; joining the first filter section and the at least one second filter so as to form a smoking device filter.

In one embodiment, the present invention provides a process for producing a smoking device filter comprising: providing a first filter section, providing at least a second filter section, the second filter section having a porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; joining the first filter section and the at least one second filter so as to form a smoking device filter.

In one embodiment, the present invention provides a process for producing a smoking device filter comprising: providing a first filter section, providing at least a second filter section, the second filter section having a porous mass having an active particle and a binder particle, the porous mass having: a carbon loading of at least about 6 mg/mm, an EPD of

about 20 mm of water or less per mm of porous mass; joining the first filter section and the at least one second filter so as to form a smoking device filter.

In one embodiment, the present invention provides a method of smoking a smoking device comprising: heating or lighting a smoking device to form smoke, the smoking device comprising at least one filter section having a porous mass having an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; and drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass.

In one embodiment, the present invention provides a method of smoking a smoking device comprising: heating or lighting a smoking device to form smoke, the smoking device comprising at least one filter section having a porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; and drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass.

In one embodiment, the present invention provides a method of smoking a smoking device comprising: heating or lighting a smoking device to form smoke, the smoking device comprising at least one filter section having a porous mass having an active particle and a binder particle, the porous mass having: a carbon loading of at least about 6 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; and drawing the smoke through the smoking device, wherein the filter section reduces the presence of at least one component in the smoke as compared to a filter without the porous mass.

In one embodiment, the present invention provides an apparatus for producing a smoking device filter having at least a plurality of sections comprising: a container comprising at least a plurality of first filter section pieces; a second container comprising at least a plurality of second filter section pieces, the second filter section pieces comprising a porous mass having an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 or less mm of water or less per mm of porous mass; a joiner section wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides an apparatus for producing a smoking device filter having at least a plurality of sections comprising: a container comprising at least a plurality of first filter section pieces; a second container comprising at least a plurality of second filter section pieces, the second filter section pieces comprising a porous mass having an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; a joiner section wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped to form a smoking device filter; and a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides an apparatus for producing a smoking device filter having at least a plurality of sections comprising: a container comprising at least a plurality of first filter section pieces; a second container comprising at least a plurality of second filter section pieces, the second filter section pieces comprising a

porous mass having an active particle and a binder particle, the porous mass having: a carbon loading of at least about 6 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; a joiner section wherein a first filter section piece and a second filter section piece are joined; a wrapping area wherein the first filter section piece and the second filter section piece are wrapped to form a smoking device filter; a conveyor to transport the smoking device filter to a subsequent area for storage or use.

In one embodiment, the present invention provides a method of making a smoking device filter comprising: providing a container that comprises at least a plurality of first filter section pieces; providing a second container comprising at least a plurality of second filter section pieces, wherein the second filter section pieces comprise a porous mass that comprises an active particle and a binder particle; joining a first filter section piece and a second filter section piece end-to-end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod; and transporting the filter rod to a subsequent area for storage or use.

In one embodiment, the present invention provides a process for producing a smoking device comprising: providing a filter rod comprising at least one filter section comprising a porous mass that comprises an active particle and a binder particle, the porous mass having: an active particle loading of at least about 1 mg/mm, an EPD of about 20 mm of water or less per mm of porous mass; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two filters having at least one filter section, each filter section comprising a porous mass that comprises an active particle and a binder particle; and joining at least one of the filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In one embodiment, the present invention provides a process for producing a smoking device comprising: providing a filter rod comprising at least one filter section comprising a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold

nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; providing a tobacco column; cutting the filter rod transverse to its longitudinal axis through the center of the rod to form at least two filters having at least one filter section, each filter section comprising a porous mass that comprises an active particle and a binder particle; and joining at least one of the filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

In one embodiment, the present invention provides a smoking device holder comprising a filter that comprises at least one filter section having an active particle loading of at least about 1 mg/mm and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a smoking device holder comprising a filter that comprises at least one filter section having an active particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device holder comprising a filter that comprises at least one filter section having a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a pipe comprising a filter that comprises at least one filter section having a porous mass, the porous mass having an active particle loading of at least about 1 mg/mm and an EPD of 20 mm of water or less per mm of porous mass.

In one embodiment, the present invention provides a pipe comprising a filter that comprises at least one filter section having a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

In one embodiment, the present invention provides a smoking device filter comprising at least three neighboring in-series sections, wherein a first section has an active particle loading of at least about 1 mg/mm and an EPD of about 20 mm of water or less per mm of porous mass, and a second section and a third section that each comprise a section that is selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

In one embodiment, the present invention provides a smoking device filter comprising at least three neighboring in-series sections, wherein a first section has a porous mass that comprises an active particle and a binder particle, the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic

nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof; and a second section and a third section that each comprise a section that is selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

In one embodiment, the present invention provides a smoking device having a filter that comprises a porous mass that comprises an active particle and a binder particle, the active particle being capable of removing or reducing at least one smoke component from a smoke stream, the smoke component being selected from the group consisting of: acetaldehyde, acetamide, acetone, acrolein, acrylamide, acrylonitrile, aflatoxin B-1, 4-aminobiphenyl, 1-aminonaphthalene, 2-aminonaphthalene, ammonia, ammonium salts, anabasine, anatabine, 0-anisidine, arsenic, A-α-C, benz[a]anthracene, benz[b]fluoroanthene, benz[j]aceanthrylene, benz[k]fluoroanthene, benzene, benzo(b)furan, benzo[a]pyrene, benzo[c]phenanthrene, beryllium, 1,3-butadiene, butyraldehyde, cadmium, caffeic acid, carbon monoxide, catechol, chlorinated dioxins/furans, chromium, chrysene, cobalt, coumarin, a cresol, crotonaldehyde, cyclopenta[c,d]pyrene, dibenz(a,h)acridine, dibenz(a,j)acridine, dibenz[a,h]anthracene, dibenzo(c,g)carbazole, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, 2,6-dimethylaniline, ethyl carbamate (urethane), ethylbenzene, ethylene oxide, eugenol, formaldehyde, furan, glu-P-1, glu-P-2, hydrazine, hydrogen cyanide, hydroquinone, indeno[1,2,3-cd]pyrene, IQ, isoprene, lead, MeA-α-C, mercury, methyl ethyl ketone, 5-methylchrysene, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), naphthalene, nickel, nicotine, nitrate, nitric oxide, a nitrogen oxide, nitrite, nitrobenzene, nitromethane, 2-nitropropane, N-nitrosoanabasine (NAB), N-nitrosodiethanolamine (NDELA), N-nitrosodiethylamine, N-nitrosodimethylamine (NDMA), N-

nitrosoethylmethylamine, N-nitrosomorpholine (NMOR), N-nitrosonornicotine (NNN), N-nitrosopiperidine (NPIP), N-nitrosopyrrolidine (NPYR) , N-nitrososarcosine (NSAR), phenol, PhlP, polonium-210 (radio-isotope), propionaldehyde, propylene oxide, pyridine, quinoline, resorcinol, selenium, styrene, tar, 2-toluidine, toluene, Trp-P-1, Trp-P-2, uranium-235 (radio-isotope), uranium-238 (radio-isotope), vinyl acetate, vinyl chloride, and any combination thereof.

In one embodiment, the present invention provides a process for producing a smoking device filter comprising: providing a first filter section, providing at least a second filter section, the second filter section having a porous mass having an active particle and a binder particle, the active particle being capable of removing or reducing at least one smoke component from a smoke stream, the smoke component being selected from the group consisting of: acetaldehyde, acetamide, acetone, acrolein, acrylamide, acrylonitrile, aflatoxin B-1, 4-aminobiphenyl, 1-aminonaphthalene, 2-aminonaphthalene, ammonia, ammonium salts, anabasine, anatabine, 0-anisidine, arsenic, A-α-C, benz[a]anthracene, benz[b]fluoroanthene, benz[j]aceanthrylene, benz[k]fluoroanthene, benzene, benzo(b)furan, benzo[a]pyrene, benzo[c]phenanthrene, beryllium, 1,3-butadiene, butyraldehyde, cadmium, caffeic acid, carbon monoxide, catechol, chlorinated dioxins/furans, chromium, chrysene, cobalt, coumarin, a cresol, crotonaldehyde, cyclopenta[c,d]pyrene, dibenz(a,h)acridine, dibenz(a,j)acridine, dibenz[a,h]anthracene, dibenzo(c,g)carbazole, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, 2,6-dimethylaniline, ethyl carbamate (urethane), ethylbenzene, ethylene oxide, eugenol, formaldehyde, furan, glu-P-1, glu-P-2, hydrazine, hydrogen cyanide, hydroquinone, indeno[1,2,3-cd]pyrene, IQ, isoprene, lead, MeA-α-C, mercury, methyl ethyl ketone, 5-methylchrysene, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), naphthalene, nickel, nicotine, nitrate, nitric oxide, a nitrogen oxide, nitrite, nitrobenzene, nitromethane, 2-nitropropane, N-nitrosoanabasine (NAB), N-nitrosodiethanolamine (NDELA), N-nitrosodiethylamine, N-nitrosodimethylamine (NDMA), N-nitrosoethylmethylamine, N-nitrosomorpholine (NMOR), N-nitrosonornicotine (NNN), N-nitrosopiperidine (NPIP), N-nitrosopyrrolidine (NPYR) , N-nitrososarcosine (NSAR), phenol, PhlP, polonium-210 (radio-isotope), propionaldehyde, propylene oxide, pyridine, quinoline, resorcinol, selenium, styrene, tar, 2-toluidine, toluene, Trp-P-1, Trp-P-2, uranium-235 (radio-isotope), uranium-238 (radio-isotope), vinyl acetate, vinyl chloride, and any

combination thereof; and joining the first filter section and the at least one second filter so as to form a smoking device filter.

In one embodiment, the present invention provides a porous mass having a void volume in the range of about 40% to about 90%.

In one embodiment, the present invention provides a filter that comprises a porous mass having a void volume in the range of about 40% to about 90%.

In one embodiment, the present invention provides a smoking device that comprises a filter that comprises a porous mass having a void volume in the range of about 40% to about 90%.

In some embodiments, the present invention provide a filter that may be used in a smoking device, the filter comprising a porous mass that comprises an active particle and a binder particle, the filter having at least one of the following or any combination thereof:

(a) the active particle comprising an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagentic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof;

(b) the porous mass having a void volume in the range of about 40% to about 90%;

(c) the active particle comprising carbon, and the porous mass having a carbon loading of at least about 6 mg/mm, and an EPD of about 20 mm of water or less per mm of porous mass; and

(d) the porous mass having an active particle loading of at least about 1 mg/mm and an EPD of 20 mm of water or less per mm of porous mass.

To facilitate a better understanding of the present invention, the following examples of representative embodiments are given. In no way should the following examples be read to limit, or to define, the scope of the invention.

Examples

In the following example, the effectiveness of a porous mass in removing certain components of the cigarette smoke is illustrated. The porous mass was made from 25 weight % GUR 2105 from Ticona, of Dallas, TX and 75 weight % PICA RC 259 (95% active carbon) from PICA USA, Inc. of Columbus, OH. The porous mass has a % void volume of 72% and an encapsulated pressure drop (EPD) of 2.2 mm of water/mm of porous mass length. The porous mass has a circumference of about 24.5 mm. The PICA RC 259 carbon had an average particle size of 569 microns (μ). The porous mass was made by mixing the resin (GUR 2105) and carbon (PICA RC 259) and then filling a mold with the mixture without pressure on the heated mixture (free sintering). Then, the mold was heated to 200°C for 40 minutes. Thereafter, the porous mass was removed from the mold and allowed to cool. A defined-length section of the porous mass was combined with a sufficient amount of cellulose acetate tow to yield a filter with a total encapsulated pressure drop of 70 mm of water. All smoke assays were performed according to tobacco industry standards. All cigarettes were smoked using the Canadian intense protocol (*i.e.*, T-115, "*Determination of "Tar," Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke*," Health Canada, 1999) and a Cerulean 450 smoking machine.

Table 1

Carbonyls μg/cigarette	**Control**	**5 mm porous mass 20 mm Tow**	**%**	**10 mm porous mass 15 mm Tow**	**%**	**15 mm porous mass 13 mm Tow**	**%**
Formaldehyde	10.4	5.1	-51	0.0	-100	0.0	-100
Acetaldehyde	295.3	211.2	-28	186.8	-37	188.5	-36
Acetone	601.0	287.7	-52	104.7	-83	95.4	-84
Propionaldehyde	100.2	42.4	-58	16.0	-84	14.9	-85
Crotonaldehyde	101.7	29.4	-71	0.0	-100	0.0	-100
Butyraldehyde	114.8	43.3	-62	0.0	-100	0.0	-100
Methyl Ethyl Ketone	178.8	64.2	-64	20.8	-88	21.5	-88
Acrolein	101.8	45.3	-56	13.6	-87	14.8	-85

Table 2

Other compounds	Control	5 mm porous mass 20 mm Tow	%	10 mm porous mass 15 mm Tow	%	15 mm porous mass 13 mm Tow	%
Benzene (µg/cig)	79.0	54.0	-32	22.0	-72	20.0	-75
1,3 butadiene (µg/cig)	220.0	192.0	-13	162.0	-26	98.0	-55
Benzo[a]Pyrene (ng/cig)	5.0	0.0	-100	0.0	-100	0.0	-100

Table 3

Tar, nicotine, etc	Control	5 mm porous mass 20 mm Tow	Control	10 mm porous mass 15 mm Tow	Control	15 mm porous mass 13 mm Tow
Tar (mg/cig)	39.0	37.1	35.8	34.4	33.7	34.9
Nicotine (mg/cig)	2.8	2.8	2.5	2.6	2.6	2.7
Water (mg/cig)	17.7	17.0	14.0	13.3	14.7	11.2
CO (mg/cig)	34.4	35.4	32.6	32.1	31.4	31.2

In the following example, the effectiveness of a porous mass in removing certain components of the cigarette smoke is illustrated. The porous mass was made from 30 weight % GUR X192 from Ticona, of Dallas, TX and 70 weight % PICA 30x70 (60% active carbon) from PICA USA, Inc. of Columbus, OH. The porous mass has a % void volume of 75% and an encapsulated pressure drop (EPD) of 3.3 mm of water/mm of porous mass length. The porous mass has a circumference of about 24.5 mm. The PICA 30x70 carbon had an average particle size of 405 microns (µ). The porous mass was made by mixing the resin (GUR X192) and carbon (PICA 30x70) and then filling a mold with the mixture without pressure on the heated mixture (free sintering). Then, the mold was heated to 220°C for 60 minutes. Thereafter, the porous mass was removed from the mold and allowed to cool. A defined-length section of the porous mass was combined with a sufficient amount of cellulose acetate tow to yield a filter with a total encapsulated pressure drop of 70 mm of water. All smoke assays were performed according to tobacco industry standards. All cigarettes were smoked using the Canadian intense protocol (*i.e.*, T-115, "*Determination of "Tar," Nicotine and*

Carbon Monoxide in Mainstream Tobacco Smoke," Health Canada, 1999) and a Cerulean 450 smoking machine.

Table 4

Carbonyls µg/cigarette	Control	5 mm porous mass 20 mm Tow	%	10 mm porous mass 15 mm Tow	%	15 mm porous mass 13 mm Tow	%
Formaldehyde	7.9	5.3	-32	0.0	-100	0.0	-100
Acetaldehyde	477.7	478.0	-0	413.5	-13	337.8	-29
Acetone	557.4	433.4	-22	214.0	-62	121.2	-78
Propionaldehyde	118.5	72.5	-39	31.6	-73	17.4	-85
Crotonaldehyde	83.0	38.5	-54	14.5	-83	10.7	-87
Butyraldehyde	86.8	39.7	-54	10.7	-88	5.9	-93
Methyl Ethyl Ketone	195.7	100.8	-49	37.1	-81	19.2	-90
Acrolein	84.0	55.5	-34	22.5	-73	13.3	-84

Table 5

Other compounds	Control	5 mm porous mass 20 mm Tow	%	10 mm porous mass 15 mm Tow	%	15 mm porous mass 13 mm Tow	%
Benzene (µg/cig)	118.7	82.7	-30	40.1	-66	23.5	-80
1,3 butadiene (µg/cig)	257.3	259.1	1	204.4	-21	148.7	-42
Benzo[a]Pyrene (ng/cig)	6.4	3.0	-53	0.0	-100	0.0	-100

Table 6

Tar, nicotine, etc	Control	5 mm porous mass 20 mm Tow		10 mm porous mass 15 mm Tow		15 mm porous mass 13 mm Tow
Tar (mg/cig)	41.5	41.5		41.2		38.4
Nicotine (mg/cig)	2.8	2.8		2.9		2.8
Water (mg/cig)	16.7	17.0		17.7		12.6
CO (mg/cig)	30.8	33.2		35.5		31.6

In the following example, the effectiveness of a porous ion exchange resin mass in removing certain components of the cigarette smoke is illustrated. The porous mass was made from 20 weight % GUR 2105 from Ticona, of Dallas, TX and 80 weight % of an amine based resin (AMBERLITE IRA96RF from Rohm & Haas of Philadelphia, PA). A 10 mm section of the porous mass was combined with a sufficient amount of cellulose acetate tow (12 mm) to yield a filter with a total encapsulated pressure drop of 70 mm of water. All smoke assays were performed according to tobacco industry standards. All cigarettes were smoked using the Canadian intense protocol (*i.e.*, T-115, "*Determination of "Tar," Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke*," Health Canada, 1999) and a Cerulean 450 smoking machine.

Table 7

Carbonyls µg/cigarette	Control	Ion Exchange Resin	% change
Formaldehyde	8.0	ND	-100
Acetaldehyde	491.0	192.0	-61
Acetone	519.0	589.0	14
Acrolein	65.0	28.0	-56
Propionaldehyde	114.0	72.0	-37
Crotonaldehyde	83.0	45.0	-45
Methyl Ethyl Ketone	179.0	184.0	3
Butyraldehyde	54.0	61.0	13

In the following example, the effectiveness of a porous desiccant mass in removing water from the cigarette smoke is illustrated. The porous mass was made from 20 weight %

GUR 2105 from Ticona, of Dallas, TX and 80 weight % of desiccant (calcium sulfate, DRIERITE from W. A. Hammond DRIERITE Co. Ltd. of Xenia, OH). A 10 mm section of the porous mass was combined with a sufficient amount of cellulose acetate tow (15 mm) to yield a filter with a total pressure drop of 70 mm of water. All smoke assays were performed according to tobacco industry standards. All cigarettes were smoked using the Canadian intense protocol (*i.e.*, T-115, "*Determination of "Tar," Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke*," Health Canada, 1999) and a Cerulean 450 smoking machine.

Table 8

mg/cigarette	**Control**	**Desiccant Conditioned**	**% Change**	**Desiccant Unconditioned**	**% Change**
Cambridge Particular Matter	62.0	55.6	-10.3	54.0	-12.8
Water Deliveries	15.0	12.8	-15.1	11.2	-25.6
Nicotine Deliveries	2.7	2.9	8.0	2.9	8.0
Tar Deliveries	44.2	39.9	-9.7	40.0	-9.7
Carbon monoxide	35.0	35.9	2.5	35.0	0.1
Tar/Nicotine Ratio	16.5	13.8	-16.4	13.8	-16.4

In the following example, a carbon-on-tow filter element is compared to the inventive porous mass. In this comparison, equal total carbon loadings are compared. In other words, the amount of carbon in each element is the same; the length of the element is allowed to change so that equal amounts of carbon were obtained. The reported change in smoke component is made in relation to conventional cellulose acetate filter (the % change is in relation to a conventional cellulose acetate filter). All filter tips consisted of the carbon element and cellulose acetate tow. All filter tips were tipped with a sufficient length of cellulose acetate filter tow to obtain a targeted filter pressure drop of 70 mm of water. The total filter length was 20 mm (carbon element and tow element). The carbon was 30x70, 60% active PICA carbon. All cigarettes were smoked using the Canadian intense protocol

(i.e., T-115, "*Determination of "Tar," Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke*," Health Canada, 1999).

Table 9

	Total Carbon Loading = 39 mg		**Total Carbon loading = 56 mg**	
Carbonyls	Carbon-on-tow(10 mm) % change	porous mass (2 mm) % change	Carbon-on-tow (10 mm) % change	porous mass (3 mm) % change
Formaldehyde	-24.6	-13.7	-32.3	-27.6
Acetaldehyde	-4.5	-3.4	-6.3	-12.5
Acetone	-19.7	-33.1	-27.3	-49.2
Propionaldehyde	-32.0	-42.2	-38.6	-55.7
Crotonaldehyde	-64.5	-57.3	-71.0	-68.0
Butyraldehyde	7.9	-34.4	-8.2	-54.4
Methyl Ethyl Ketone	-35.4	-48.3	-45.6	-63.2
Acrolein	-22.5	-40.3	-31.3	-52.6

In the following example, a porous mass made with a highly active carbon (95% CCl_4 absorption) is compared with a porous mass made with a lower active carbon (60% CCl_4 absorption). The combined filters were made using a 10 mm section of the porous mass plus a sufficient length of cellulose acetate to reach a targeted combined encapsulated pressure drop of 69-70 mm of water. These filters were attached to a commercial tobacco column and smoked on a Cerulean SM 450 smoking machine using the Canadian intense smoking protocol (*i.e.*, T-115, "*Determination of "Tar," Nicotine and Carbon Monoxide in Mainstream Tobacco Smoke*," Health Canada, 1999). The high active carbon was PICA RC 259, particle size 20x50, 95% activity (CCl_4 adsorption). The low active carbon was PICA PCA, particle size 30x70, 60% activity (CCl_4 adsorption). The carbon loading of each porous mass element was 18.2 mg/mm, low active carbon, and 16.7 mg/mm, high active carbon. The data is reported in relation to a conventional cellulose acetate filter.

Table 10

Carbonyls	60% active carbon % change	95% active carbon % change
Formaldehyde	-100.0	-100.0
Acetaldehyde	-65.8	-37.0
Acetone	-89.9	-83.0
Propionaldehyde	-91.0	-84.0
Crotonaldehyde	-100.0	-100.0
Butyraldehyde	-100.0	-100.0
Methyl Ethyl Ketone	-100.0	-88.0
Acrolein	-90.7	-87.0

Table 11

Other compounds	60% active carbon % change	95% active carbon % change
Benzene	2.6	-72.0
1,3 butadiene	-3.2	-26.0
Benzo[a]Pyrene	-100.0	-100.0

In the following example, the effect of particle size on encapsulated pressure drop (EPD) is illustrated. Porous masses with carbons of various particle sizes were molded into rods (length=39 mm and circumference=24.5 mm) by adding the mixture of carbon and resin (GUR 2105) into a mold and heating (free sintering) the mixture at 200°C for 40 minutes. Thereafter, the porous mass was removed from the mold and allowed to cool to room temperature. The EPD's were determined for 10 porous masses and averaged.

Table 12

	Carbon:GUR Weight Ratio	Average Particle Size	Average EPD	
Carbon		**(μ)**	**(mm of water/mm of porous mass length)**	
RC 259	75:25	569.0	2.2	
PICA	80:20	402.5	3.5	
NC506	75:25	177.5	25.0	

In the following example, porous masses, as set forth in Tables 1-3, are used to demonstrate that filters made with such porous masses can be used to manufacture cigarettes that meet World Health Organization (WHO) standards for cigarettes. WHO standards may be found in WHO Technical Report Series No. 951, *The Scientific Basis of Tobacco Product Regulation*, World Health Organization (2008), Table 3.10, page 112. The results reported below, show that the porous mass can be used to reduce the listed components from tobacco smoke to a level below that recommended by the WHO.

Table 13

(μg)	Median [1]	Upper limit (125% of median)	Highest delivery brand[1]	% reduction [2] 5 mm	% reduction [2] 10 mm	Amount delivered 5 mm	Amount delivered 10 mm
1,3Butadiene	53.3	66.7	75.5	13	26	65.7	55.9
Acetaldehyde	687.6	859.5	997.2	28	37	718.0	628.2
Acrolein	66.5	83.2	99.5	56	87	43.8	12.9
Benzene	38.0	47.5	51.1	32	72	34.7	14.3
Benzo[a]pyrene	9.1	11.4	13.8	100	100	0.0	0.0
Formaldehyde	37.7	47.1	90.5	51	100	44.4	0.0

[1] Information based on data in Counts, ME, et al., (2004) *Mainstream smoke toxicant yields and predicting relationships from a worldwide market sample of cigarette brands: ISO*

smoking conditions, Regulatory Toxicology and Pharmacology, 39:111-134, and Counts ME, et al., (2005) *Smoke composition and predicting relationships for international commercial cigarettes smoked with three machine-smoking conditions,* Regulatory Toxicology and Pharmacology, 41:185-227.

[2] % reductions obtained from Tables 1-3 above.

In the following example, porous mass where ion exchange resins are used as the active particles, as set forth in Table 4, are used to demonstrate that filters made with such porous masses can be used to manufacture cigarettes that meet World Health Organization (WHO) standards for cigarettes. WHO standards may be found in WHO Technical Report Series No. 951, *The Scientific Basis of Tobacco Product Regulation,* World Health Organization (2008), Table 3.10, page 112. The results reported below, show that the porous mass can be used to reduce the certain components from tobacco smoke to a level below that recommended by the WHO.

Table 14

(µg)	Median[1]	Upper limit (125% of median)	Highest delivery brand[1]	% reduction[2] 10 mm	Amount delivered 10 mm
Acetaldehyde	687.6	859.5	997.2	61	388.9
Acrolein	66.5	83.2	99.5	56	43.8
Formaldehyde	37.7	47.1	90.5	100	0.0

[1] Information based on data in Counts, ME, et al., (2004) *Mainstream smoke toxicant yields and predicting relationships from a worldwide market sample of cigarette brands: ISO smoking conditions*, Regulatory Toxicology and Pharmacology, 39:111-134, and Counts ME, et al., (2005) *Smoke composition and predicting relationships for international commercial cigarettes smoked with three machine-smoking conditions,* Regulatory Toxicology and Pharmacology, 41:185-227.

[2] % reductions obtained from Table 4 above.

In the following example, the encapsulated pressure drop was measured for a filter. The porous masses were formed by mixing the binder particles (ultra high molecular weight polyethylene) and active particles (carbon) at a desired weight ratio in a tumbled jar until well mixed. A mold formed of stainless steel tube having a length of 120 mm, an inside diameter of 7.747 mm, and a circumference of 24.34 mm. The circumference of each of the molds

was lined with a standard, non-porous filter plug wrap. With a fitting on the bottom to close off the bottom of the mold, the mixture was then placed into the paper-lined molds to reach to the top of the mold. The mold is tamped (bounced) ten times off of a rubber stopper and then topped off to again reach the top of the paper within the mold and bounced three times. The top of the mold is then sealed and placed in an oven and heated, without the addition of pressure, to a temperature of 220°C for 25 to 45 minutes, depending on the mold design, the molecular weight of the binder particles, and the heat transfer. The encapsulated pressure drop was measured in mm of water. Those components of the mixtures and test results are listed below in Tables 15 - 20 below. The polyethylene binder particles used are from Ticona Polymers LLC, a division of Celanese Corporation of Dallas, TX under the following tradenames, the molecular weights are in parentheses: GUR® 2126 (approximately 4 x 10^6 g/mol), GUR® 4050-3 (approximately 8-9 x 10^6 g/mol), GUR® 2105 (approximately 0.47 x 10^6 g/mol), GUR® X192 (approximately 0.60 x 10^6 g/mol), GUR® 4012 (approximately 1.5 x 10^6 g/mol), and GUR® 4022-6 (approximately 4 x 10^6 g/mol).

Table 15
Comparative Examples

*Carbon Loading for Comparative Examples (*30x70 Pica Carbon) Carbon:Binder Particle Weight Ratio	Comparative Example 1 (GUR® 2126) Average mg Carbon/mm	Comparative Example 2 (GUR® 4050-3) Average mg Carbon/mm	Comparative Example 3 (1:1 Blend: GUR® 2126: GUR® 4050-3) Average mg Carbon/mm
50/50	11.10	20.65	12.66
60/40	13.90	20.40	15.41
70/30	17.15	19.89	18.30
80/20	20.52	16.61	20.66
90/10	21.01	13.99	21.11

Table 16
Comparative Examples

Encapsulated Pressure Drop for Comparative Examples (30x70 Pica Carbon) Carbon:Binder Particle Weight Ratio	Comparative Example 1 (GUR® 2126) Average mm of water/mm	Comparative Example 2 (GUR® 4050-3) Average mm of water/mm	Comparative Example 3 (1:1 Blend GUR® 2126: GUR® 4050-3) Average mm of water/mm

50/50	20.0	11.9	20.1
60/40	20.0	19.8	20.0
70/30	20.0	20.0	20.0
80/20	19.9	19.8	20.3
90/10	16.0	20.0	15.2

Table 17
Porous Masses of the Present Invention

Carbon Loading (30x70 Pica Carbon) Carbon:Binder Particle Weight Ratio	Binder Particle 1 (GUR® 2105) Average mg Carbon/mm	Binder Particle 2 (GUR® X192) Average mg Carbon/mm	Binder Particle 3 (GUR® 4012) Average mg Carbon/mm	Binder Particle 4 (GUR® 4022-6) Average mg Carbon/mm
50/50	NA	NA	11.66	10.51
60/40	10.61	11.16	13.35	12.66
65/35	11.70	12.23	NA	NA
70/30	12.70	13.22	15.01	14.55
75/25	13.81	14.30	NA	NA
80/20	14.75	15.34	16.20	16.57

Where NA is noted, rods were not made for these cells.

Table 18
Porous Masses of the Present Invention

Encapsulated Pressure Drop (30x70 Pica Carbon) Carbon:Binder Particle Weight Ratio	Binder Particle 1 (GUR® 2105) Average mm of water/mm	Binder Particle 2 (GUR®X192) Average mm of water/mm	Binder Particle 3 (GUR® 4012) Average mm of water/mm	Binder Particle 4 (GUR® 4022-6) Average mm of water/mm
50/50	NA	NA	18.48	7.87
60/40	0.94	2.32	15.71	8.00
65/35	1.48	2.40	NA	NA
70/30	1.59	2.52	11.43	6.22
75/25	1.88	2.74	NA	NA
80/20	2.64	3.25	7.81	5.41

Where NA is noted, rods were not made for these cells.

Table 19
Porous Masses of the Present Invention

Pica Carbon Mesh	Carbon Weight %	Binder Particle Blend[1] Weight %	Average Carbon mg/mm	Average EPD mm of water/mm of porous mass
80x325	50	50	9.14	2.0
80x325	60	40	12.24	6.4
80x325	70	30	14.05	11.4
80x325	80	20	17.02	19.3

1. The binder blend was a 1:1 weight mixture of GUR® 2105 and GUR® X192.

Table 20
Additional Comparative Examples

Commercial cigarette filters (Cellulose acetate)	**Length (mm)**	**Average of 20 filters EPD mm of water/mm**	**EPD/mm of porous mass length**
Marlboro	21	70	3.3
Winston	27	79	2.9

The data shown in Figures 6 through 9 were generated from additional EPD testing of porous masses of the present invention based on carbon loading and comparative samples. The porous masses were formed by mixing the binder particles, specifically ultra high molecular weight polyethylene chosen from GUR® 2105, GUR® X192, GUR® 4012, and GUR® 8020), and active particles (carbon) at a desired weight ratio in a tumbled jar until well mixed. A mold formed of stainless steel tube having a length of about 120 mm, an inside diameter of about 7.747 mm, and a circumference of about 24.5 mm (theoretical) or about 17.4 (theoretical). The circumference of each of the molds was lined with a standard, non-porous filter plug wrap. With a fitting on the bottom to close off the bottom of the mold, the mixture was then placed into the paper-lined molds to reach to the top of the mold. The mold is tapped (bounced) ten times off of a rubber stopper and then topped off to again reach the top of the paper within the mold and bounced three times. The top of the mold is then sealed and placed in an oven and heated, without the addition of pressure, to a temperature of 220°C for 25 to 45 minutes, depending on the mold design, the molecular weight, and the heat transfer. The length of the filter is then cut down to 100 mm. The circumference of the

filters tested is reported. These were substantially circular in shape. The encapsulated pressure drop was measured in mm of water according to the CORESTA procedure.

Figure 6 is a comparative document that shows the results of encapsulated pressure drop testing for carbon-on-tow filters having an average circumference of about 24.5 mm.

Figure 7 shows the results of encapsulated pressure drop testing for porous mass filters of the present invention (comprising polyethylene and carbon) having an average circumference of about 24.5 mm.

Figure 8 is a comparative document that shows the results of encapsulated pressure drop testing for carbon-on-tow filters having an average circumference of about 16.9 mm.

Figure 9 shows the results of encapsulated pressure drop testing for porous mass filters of the present invention (comprising polyethylene and carbon) having an average circumference of about 16.9 mm.

Therefore, the present invention is well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the present invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered, combined, or modified and all such variations are considered within the scope and spirit of the present invention. While compositions and methods are described in terms of "comprising," "containing," or "including" various components or steps, the compositions and methods can also "consist essentially of" or "consist of" the various components and steps. All numbers and ranges disclosed above may vary by some amount. Whenever a numerical range with a lower limit and an upper limit is disclosed, any number and any included range falling within the range is specifically disclosed. In particular, every range of values (of the form, "from about a to about b," or, equivalently, "from approximately a to b," or, equivalently, "from approximately a-b") disclosed herein is to be understood to set forth every number and range encompassed within the broader range of values. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. Moreover, the indefinite articles "a" or "an," as used in the claims, are defined herein to mean one or more than one of the element that it introduces. If there is any conflict in the usages of

a word or term in this specification and one or more patent or other documents that may be incorporated herein by reference, the definitions that are consistent with this specification should be adopted.

Claims

What is claimed:

1. A filter comprising:

a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass.

2. The filter of claim 1, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

3. The filter of claim 1, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

4. The filter of claim 1, wherein the porous mass has a void volume of about 40% to about 90%.

5. The filter of claim 1, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

6. The filter of claim 1, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

7. The filter of claim 1, wherein the binder particle is a non-fibrous binder particle.

8. The filter of claim 1, wherein the binder particle comprises a thermoplastic material.

9. The filter of claim 1, wherein the binder particle has a melt flow index less than or equal to about 3.5 g/10min at 190°C and 15 Kg.

10. The filter of claim 1, wherein the binder particle has a melt flow index less than or equal to about 2.0 g/10min at 190°C and 15 Kg.

11. The filter of claim 1, wherein the binder particle has a shape selected from the group consisting of: spherical, hyperion, asteroidal, chrondular or interplanetary dust-like, granulated, potato, irregular, and any combination thereof.

12. The filter of claim 1, wherein the binder particle has a particle size in at least one dimension ranging from about 0.1 nanometers to about 5000 microns.

13. The filter of claim 1, wherein the porous mass comprises a plurality of active particles and a plurality of binder particles, and wherein the active particles and the binder particles are bound together at a plurality of randomly distributed points throughout the porous mass.

14. The filter of claim 1, wherein the active particle comprises activated carbon.

15. The filter of claim 1, wherein the active particle comprises at least one selected from the group consisting of: an ion exchange resin, a desiccant, a silicate, a molecular sieve, a metallocene, a silica gel, activated alumina, a zeolite, perlite, sepiolite, Fuller's Earth, magnesium silicate, a metal oxide, iron oxide, activated carbon, and any combination thereof.

16. The filter of claim 1, wherein the active particle has a particle size in at least one dimension ranging from about 0.1 nanometers to about 5000 microns.

17. The filter of claim 1, wherein the porous mass comprises a plurality of active particles and a plurality of binder particles, and wherein the porous mass comprises a ratio of the active particles to the binder particles ranging from about 1 wt% active particles and about 99 wt% binder particles to about 99 wt% active particles and about 1 wt% binder particles.

18. The filter of claim 1, wherein the porous mass comprises a plurality of active particles and a plurality of binder particles, and wherein the porous mass comprises a ratio of the active particles to the binder particles ranging from about 75 wt% active particles and

about 25 wt% binder particles to about 90 wt% active particles and about 10 wt% binder particles.

19. The filter of claim 1, wherein the porous mass has a length of about 1 mm to about 35 mm.

20. The filter of claim 1, wherein the porous mass has a shape selected from the group consisting of: a helical shape, a triangular shape, a disk shape, and a square shape.

21. The filter of claim 1, wherein the porous mass comprises activated carbon, and wherein the porous mass is capable of reducing acetaldehydes in a smoke stream by about 3.0%/mm to about 6.5%/mm length of porous mass; acrolein in a smoke stream by about 7.5%/mm to about 12.5%/mm length of porous mass; benzene in a smoke stream by about 5.5%/mm to about 8.0%/mm length of porous mass; benzo[a]pyrene in a smoke stream by about 9.0%/mm to about 21.0%/mm length of porous mass; 1,3-butadiene in a smoke stream by about 1.5%/mm to about 3.5%/mm length of porous mass; and formaldehyde in a smoke stream by about 9.0/mm to about 11.0%/mm length of porous mass.

22. A smoking device comprising:

a smokeable substance; and

a filter comprising a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass.

23. The smoking device of claim 22, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

24. The smoking device of claim 22, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

25. The smoking device of claim 22, wherein the porous mass has a void volume of about 40% to about 90%.

26. The smoking device of claim 22, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a

fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

27. The smoking device of claim 22, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

28. The smoking device of claim 22, wherein the smokeable substance comprises at least one selected from the group consisting of: tobacco, bright leaf tobacco, burley tobacco, Oriental tobacco, Turkish tobacco, Cavendish tobacco, corojo tobacco, criollo tobacco, Perique tobacco, shade tobacco, white burley tobacco, and any combination thereof.

29. The smoking device of claim 22, wherein the filter consists essentially of the porous mass.

30. The smoking device of claim 22, wherein the filter is substantially degradable over time.

31. The smoking device of claim 22, wherein the filter comprises a plurality of sections, wherein at least one section comprises the porous mass.

32. The smoking device of claim 31, wherein the filter comprises at least one section that comprises at least one element selected from the group consisting of: cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, a peripheral filter of fibrous tow and a core of a web material, carbon-on-tow, a Dalmatian filter, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a void chamber, a baffled void chamber, and any combination thereof.

33. The smoking device of claim 22, wherein the filter comprises a cavity.

34. The smoking device of claim 33, wherein the cavity comprises at least one selected from the group consisting of: granulated carbon, a flavorant, a capsule, and any combination thereof.

35. The smoking device of claim 22, wherein the filter further comprises a flavorant that comprises at least one selected from the group consisting of: tobacco, clove, ground clove, ground clove flower, cocoa, menthol, cloves, cherry, chocolate, orange, mint, mango, vanilla, cinnamon, tobacco, anethole, licorice, limonene, citrus, eugenol, and any combination thereof.

36. The smoking device of claim 22, wherein the porous mass further comprises a flavorant that comprises at least one selected from the group consisting of: menthol, clove, cherry, chocolate, orange, mint, mango, vanilla, cinnamon, tobacco, and any combination thereof.

37. The smoking device of claim 22, wherein the filter has a diameter from about 5 mm to about 10 mm and a length from about 5 mm to about 35 mm.

38. The smoking device of claim 22, wherein the filter has a diameter from about 0.5 mm to about 5 mm.

39. The smoking device of claim 22, wherein the porous mass has a void volume of about 40% to about 90%.

40. The smoking device of claim 22, wherein the binder particle has a melt flow index less than or equal to about 3.5 g/10min at 190°C and 15 Kg.

41. The smoking device of claim 22, wherein the porous mass has an encapsulated pressure drop ranging from about 0.1 mm to about 7 mm of water per mm length of porous mass.

42. The smoking device of claim 22, wherein the active particle is capable of reducing or removing a smoke stream component selected from the group consisting of: acetaldehyde, acetamide, acetone, acrolein, acrylamide, acrylonitrile, aflatoxin B-1, 4-aminobiphenyl, 1-aminonaphthalene, 2-aminonaphthalene, ammonia, ammonium salts, anabasine, anatabine, 0-anisidine, arsenic, A-α-C, benz[a]anthracene, benz[b]fluoroanthene, benz[j]aceanthrylene, benz[k]fluoroanthene, benzene, benzo(b)furan, benzo[a]pyrene, benzo[c]phenanthrene, beryllium, 1,3-butadiene, butyraldehyde, cadmium, caffeic acid, carbon monoxide, catechol, chlorinated dioxins/furans, chromium, chrysene, cobalt,

coumarin, a cresol, crotonaldehyde, cyclopenta[c,d]pyrene, dibenz(a,h)acridine, dibenz(a,j)acridine, dibenz[a,h]anthracene, dibenzo(c,g)carbazole, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, 2,6-dimethylaniline, ethyl carbamate (urethane), ethylbenzene, ethylene oxide, eugenol, formaldehyde, furan, glu-P-1, glu-P-2, hydrazine, hydrogen cyanide, hydroquinone, indeno[1,2,3-cd]pyrene, IQ, isoprene, lead, MeA-α-C, mercury, methyl ethyl ketone, 5-methylchrysene, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), naphthalene, nickel, nicotine, nitrate, nitric oxide, a nitrogen oxide, nitrite, nitrobenzene, nitromethane, 2-nitropropane, N-nitrosoanabasine (NAB), N-nitrosodiethanolamine (NDELA), N-nitrosodiethylamine, N-nitrosodimethylamine (NDMA), N-nitrosoethylmethylamine, N-nitrosomorpholine (NMOR), N-nitrosonornicotine (NNN), N-nitrosopiperidine (NPIP), N-nitrosopyrrolidine (NPYR), N-nitrososarcosine (NSAR), phenol, PhIP, polonium-210 (radio-isotope), propionaldehyde, propylene oxide, pyridine, quinoline, resorcinol, selenium, styrene, tar, 2-toluidine, toluene, Trp-P-1, Trp-P-2, uranium-235 (radio-isotope), uranium-238 (radio-isotope), vinyl acetate, vinyl chloride, and any combination thereof.

43. The smoking device of claim 22, wherein the active particle comprises activated carbon.

44. The smoking device of claim 22, wherein the active particle comprises at least one selected from the group consisting of: an ion exchange resin, a desiccant, a silicate, a molecular sieve, a metallocene, a silica gel, activated alumina, a zeolite, perlite, sepiolite, Fuller's Earth, magnesium silicate, a metal oxide, iron oxide, activated carbon, a nanoparticle, and any combination thereof.

45. A smoking device filter comprising:

at least two neighboring longitudinal in-series sections,

wherein a first section comprises a porous mass that comprises an active particle and an ultra high molecular weight binder particle and wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass;

wherein a second section comprises a section that is selected from the group consisting of: a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow,

polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

46. The smoking device filter of claim 45, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

47. The smoking device filter of claim 45, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

48. The smoking device filter of claim 45, wherein the porous mass has a void volume of about 40% to about 90%.

49. The smoking device filter of claim 45, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

50. The smoking device filter of claim 45, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

51. The smoking device filter of claim 45, further comprising a third section that comprises an element selected from the group consisting of a cavity, cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate,

polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, carbon-on-tow, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a nanoparticle, a void chamber, a baffled void chamber, and any combination thereof.

52. The smoking device filter of claim 45, wherein the binder particle has a melt flow index less than or equal to about 3.5 g/10min at 190°C and 15 Kg.

53. The smoking device filter of claim 45, wherein the active particle is capable of reducing or removing a smoke stream component selected from the group consisting of: acetaldehyde, acetamide, acetone, acrolein, acrylamide, acrylonitrile, aflatoxin B-1, 4-aminobiphenyl, 1-aminonaphthalene, 2-aminonaphthalene, ammonia, ammonium salts, anabasine, anatabine, 0-anisidine, arsenic, A-α-C, benz[a]anthracene, benz[b]fluoroanthene, benz[j]aceanthrylene, benz[k]fluoroanthene, benzene, benzo(b)furan, benzo[a]pyrene, benzo[c]phenanthrene, beryllium, 1,3-butadiene, butyraldehyde, cadmium, caffeic acid, carbon monoxide, catechol, chlorinated dioxins/furans, chromium, chrysene, cobalt, coumarin, a cresol, crotonaldehyde, cyclopenta[c,d]pyrene, dibenz(a,h)acridine, dibenz(a,j)acridine, dibenz[a,h]anthracene, dibenzo(c,g)carbazole, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, 2,6-dimethylaniline, ethyl carbamate (urethane), ethylbenzene, ethylene oxide, eugenol, formaldehyde, furan, glu-P-1, glu-P-2, hydrazine, hydrogen cyanide, hydroquinone, indeno[1,2,3-cd]pyrene, IQ, isoprene, lead, MeA-α-C, mercury, methyl ethyl ketone, 5-methylchrysene, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), naphthalene, nickel, nicotine, nitrate, nitric oxide, a nitrogen oxide, nitrite, nitrobenzene, nitromethane, 2-nitropropane, N-nitrosoanabasine (NAB), N-nitrosodiethanolamine (NDELA), N-nitrosodiethylamine, N-nitrosodimethylamine (NDMA), N-nitrosoethylmethylamine, N-nitrosomorpholine (NMOR), N-nitrosonornicotine (NNN), N-nitrosopiperidine (NPIP), N-nitrosopyrrolidine (NPYR), N-nitrososarcosine (NSAR), phenol, PhIP, polonium-210 (radio-isotope), propionaldehyde, propylene oxide, pyridine, quinoline, resorcinol, selenium, styrene, tar, 2-toluidine, toluene, Trp-P-1, Trp-P-2, uranium-235 (radio-isotope), uranium-238 (radio-isotope), vinyl acetate, vinyl chloride, and any combination thereof.

54. A smoking device comprising:

a filter that comprises a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass; and

a housing capable of maintaining a smokeable substance in fluid contact with the filter.

55. The smoking device of claim 54, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

56. The smoking device of claim 54, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

57. The smoking device of claim 54, wherein the porous mass has a void volume of about 40% to about 90%.

58. The smoking device of claim 54, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

59. The smoking device of claim 54, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

60. The smoking device of claim 54, wherein the housing is at least one selected from the group consisting of: a cigarette, a cigarette holder, a cigar, a cigar holder, a pipe, a water pipe, a hookah, an electronic smoking device, a roll-your-own cigarette, a roll-your-own cigar, and a paper.

61. The smoking device of claim 54, wherein the filter has a diameter from about 5 mm to about 10 mm and a length from about 5 mm to about 35 mm.

62. The smoking device of claim 54, wherein the filter has a diameter from about 0.5 mm to about 5 mm.

63. The smoking device of claim 54, wherein the smokeable substance comprises at least one selected from the group consisting of: tobacco, bright leaf tobacco, burley tobacco, Oriental tobacco, Turkish tobacco, Cavendish tobacco, corojo tobacco, criollo tobacco, Perique tobacco, shade tobacco, white burley tobacco, and any combination thereof.

64. The smoking device of claim 54, wherein the smokeable substance is in the form of a tobacco column.

65. The smoking device of claim 64, wherein the tobacco column comprises a bendable element.

66. The smoking device of claim 54, wherein the smokeable substance comprises at least one selected from the group consisting of: tobacco, sugar, sucrose, brown sugar, invert sugar, high fructose corn syrup, propylene glycol, glycerol, cocoa, a cocoa product, a carob bean gum, a carob bean extract, a flavorant, menthol, licorice extract, diammonium phosphate, ammonium hydroxide, and any combination thereof.

67. The smoking device of claim 54, wherein the filter is removable, replaceable, disposable, recyclable, degradable, and/or any combination thereof.

68. The smoking device of claim 54, wherein the active particle is capable of reducing or removing a smoke stream component selected from the group consisting of: acetaldehyde, acetamide, acetone, acrolein, acrylamide, acrylonitrile, aflatoxin B-1, 4-aminobiphenyl, 1-aminonaphthalene, 2-aminonaphthalene, ammonia, ammonium salts, anabasine, anatabine, 0-anisidine, arsenic, A-α-C, benz[a]anthracene, benz[b]fluoroanthene, benz[j]aceanthrylene, benz[k]fluoroanthene, benzene, benzo(b)furan, benzo[a]pyrene, benzo[c]phenanthrene, beryllium, 1,3-butadiene, butyraldehyde, cadmium, caffeic acid, carbon monoxide, catechol, chlorinated dioxins/furans, chromium, chrysene, cobalt, coumarin, a cresol, crotonaldehyde, cyclopenta[c,d]pyrene, dibenz(a,h)acridine,

dibenz(a,j)acridine, dibenz[a,h]anthracene, dibenzo(c,g)carbazole, dibenzo[a,e]pyrene, dibenzo[a,h]pyrene, dibenzo[a,i]pyrene, dibenzo[a,l]pyrene, 2,6-dimethylaniline, ethyl carbamate (urethane), ethylbenzene, ethylene oxide, eugenol, formaldehyde, furan, glu-P-1, glu-P-2, hydrazine, hydrogen cyanide, hydroquinone, indeno[1,2,3-cd]pyrene, IQ, isoprene, lead, MeA-α-C, mercury, methyl ethyl ketone, 5-methylchrysene, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), naphthalene, nickel, nicotine, nitrate, nitric oxide, a nitrogen oxide, nitrite, nitrobenzene, nitromethane, 2-nitropropane, N-nitrosoanabasine (NAB), N-nitrosodiethanolamine (NDELA), N-nitrosodiethylamine, N-nitrosodimethylamine (NDMA), N-nitrosoethylmethylamine, N-nitrosomorpholine (NMOR), N-nitrosonornicotine (NNN), N-nitrosopiperidine (NPIP), N-nitrosopyrrolidine (NPYR), N-nitrososarcosine (NSAR), phenol, PhIP, polonium-210 (radio-isotope), propionaldehyde, propylene oxide, pyridine, quinoline, resorcinol, selenium, styrene, tar, 2-toluidine, toluene, Trp-P-1, Trp-P-2, uranium-235 (radio-isotope), uranium-238 (radio-isotope), vinyl acetate, vinyl chloride, and any combination thereof.

69. A pack of filters comprising:

a pack comprising at least one filter, the filter comprising a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass.

70. The pack of filters of claim 69, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

71. The pack of filters of claim 69, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

72. The pack of filters of claim 69, wherein the porous mass has a void volume of about 40% to about 90%.

73. The pack of filters of claim 69, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a

fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

74. The pack of filters of claim 69, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

75. The pack of filters of claim 69, wherein the pack is selected from the group consisting of: a hinge-lid pack, a slide-and-shell pack, a hard cup pack, a soft cup pack, and the like.

76. The pack of filters of claim 69 further comprising a polypropylene wrapper.

77. A smoking device comprising a pack of filter of claim 69.

78. A pack of smoking devices comprising:

a pack comprising at least one smoking device that comprises a filter, wherein the filter comprises a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass.

79. The pack of smoking devices of claim 78, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

80. The pack of smoking devices of claim 78, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

81. The pack of smoking devices of claim 78, wherein the porous mass has a void volume of about 40% to about 90%.

82. The pack of smoking devices of claim 78, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

83. The pack of smoking devices of claim 78, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

84. The pack of smoking devices of claim 78, wherein the filter comprises a plurality of sections, wherein at least one section comprises the porous mass.

85. The pack of smoking devices of claim 78, wherein the pack is selected from the group consisting of: a hinge-lid pack, a slide-and-shell pack, a hard cup pack, a soft cup pack, and the like.

86. The pack of smoking devices of claim 78 further comprising a polypropylene wrapper.

87. The pack of smoking devices of claim 78, wherein the smoking device is selected from the group consisting of: a cigarette and a cigar.

88. The pack of smoking devices of claim 78, wherein the smoking device is sealed as a bundle inside the pack, wherein the bundle comprises at least one smoking device.

89. A carton of smoking device packs comprising:

a container comprising at least one pack that comprises at least one smoking device, the smoking device comprising a filter that comprises a porous mass, the porous mass comprising an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material

and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass.

90. The carton of smoking device packs of claim 89, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

91. The carton of smoking device packs of claim 89, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

92. The carton of smoking device packs of claim 89, wherein the porous mass has a void volume of about 40% to about 90%.

93. The carton of smoking device packs of claim 89, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

94. The carton of smoking device packs of claim 89, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

95. The carton of smoking device packs of claim 89, wherein the active particle comprises at least one selected from the group consisting of: an ion exchange resin, a desiccant, a silicate, a molecular sieve, a metallocene, a silica gel, activated alumina, a zeolite, perlite, sepiolite, Fuller's Earth, magnesium silicate, a metal oxide, iron oxide, activated carbon, and any combination thereof.

96. The carton of smoking device packs of claim 89, wherein the filter comprises a plurality of sections, wherein at least one section comprises the porous mass.

97. The carton of smoking device packs of claim 89, wherein the container has the physical integrity to contain the weight of the packs of smoking devices.

98. The carton of smoking device packs of claim 89 further comprising a polypropylene wrapper.

99. The carton of smoking device packs of claim 89, wherein the smoking device is selected from the group consisting of: a cigarette and a cigar.

100. The carton of smoking device packs of claim 89, wherein the smoking device is sealed as a bundle inside the pack, wherein the bundle comprises at least one smoking device.

101. A method of smoking a smoking device, the method comprising:

heating or lighting a smoking device to form smoke,

wherein the smoking device comprises a smokeable substance and at least one filter section comprising a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass;

drawing the smoke through the smoking device to form a smoke stream, and

allowing the filter section to at least reduce the presence of at least one component in the smoke stream as compared to a filter without the porous mass.

102. The method of smoking a smoking device of claim 101, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

103. The method of smoking a smoking device of claim 101, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

104. The method of smoking a smoking device of claim 101, wherein the porous mass has a void volume of about 40% to about 90%.

105. The method of smoking a smoking device of claim 101, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like

carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

106. The method of smoking a smoking device of claim 101, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

107. A method for producing a smoking device, the method comprising:

providing a first filter section;

providing at least one second filter section,

wherein the second filter section comprises a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass;

joining the first filter section and at least one second filter section longitudinally so as to form a filter rod; and

joining at least a portion of the filter rod with a tobacco column to form a smoking device.

108. The method for producing a smoking device of claim 107, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

109. The method for producing a smoking device of claim 107, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

110. The method for producing a smoking device of claim 107, wherein the porous mass has a void volume of about 40% to about 90%.

111. The method for producing a smoking device of claim 107, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

112. The method for producing a smoking device of claim 107, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

113. The method of claim 107, wherein the first filter section comprises at least one element selected from the group consisting of: cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, a paper, a corrugated paper, a concentric filter, a peripheral filter of fibrous tow and a core of a web material, carbon-on-tow, a Dalmatian filter, silica, magnesium silicate, a zeolite, a molecular sieve, a metallocene, a salt, a catalyst, sodium chloride, nylon, a flavorant, tobacco, a capsule, cellulose, a cellulosic derivative, a catalytic converter, iodine pentoxide, a coarse powder, a carbon particle, a carbon fiber, a fiber, a glass bead, a void chamber, a baffled void chamber, and any combination thereof.

114. The method of claim 113, wherein the zeolite comprises at least one selected from the group consisting of: BETA, SBA-15, MCM-41, MCM-48 modified by 3-aminopropylsilyl groups, and any combination thereof.

115. A method of making a filter rod, the method comprising:

providing a container that comprises at least a plurality of first filter section pieces;

providing a second container comprising at least a plurality of second filter section pieces,

wherein the second filter section pieces comprise a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass;

joining a first filter section piece and a second filter section piece end-to-end along the longitudinal axis of the first filter section piece and the second filter section piece to form an unwrapped filter rod; and

wrapping the first filter section piece and the second filter section piece with a paper to form a filter rod.

116. The method of making a filter rod of claim 115, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

117. The method of making a filter rod of claim 115, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

118. The method of making a filter rod of claim 115, wherein the porous mass has a void volume of about 40% to about 90%.

119. The method of making a filter rod of claim 115, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

120. The method of making a filter rod of claim 115, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

121. A method of making a smoking device, the method comprising:

providing a filter rod comprising at least one filter section that comprises a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass;

providing a tobacco column;

cutting the filter rod transverse to its longitudinal axis to form at least two smoking device filters having at least one filter section that comprises a porous mass; and

joining at least one of the smoking device filters to the tobacco column along the longitudinal axis of the filter and the longitudinal axis of the tobacco column to form at least one smoking device.

122. The method of making a smoking device of claim 121, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

123. The method of making a smoking device of claim 121, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

124. The method of making a smoking device of claim 121, wherein the porous mass has a void volume of about 40% to about 90%.

125. The method of making a smoking device of claim 121, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a

magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

126. The method of making a smoking device of claim 121, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

127. The method of making a smoking device of claim 121, wherein the filter rod has a length ranging from about 80 mm to about 150 mm.

128. The method of claim 121, wherein the filter rod is cut into about 4 to about 6 filter sections of about 5 mm to about 35 mm in length.

129. A method of making a smoking device, the method comprising:

providing a tobacco column;

joining a filter to the tobacco column, the filter comprising a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass.

130. The method of claim 129, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

131. The method of claim 129, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

132. The method of claim 129, wherein the porous mass has a void volume of about 40% to about 90%.

133. The method of claim 129, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide

nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

134. The method of claim 129, wherein the wrapping material comprises at least one material selected from the group consisting of cellulose acetate, polypropylene, polyethylene, polyolefin tow, polypropylene tow, polyethylene terephthalate, polybutylene terephthalate, random oriented acetate, paper, corrugated paper, carbon-on-tow, silica, magnesium silicate, nylon, cellulose, and combinations thereof.

135. An apparatus comprising:

a container area comprising at least a plurality of first filter section pieces;

a second container area comprising at least a plurality of second filter section pieces,

wherein the second filter section pieces comprise a porous mass that comprises an active particle and an ultra high molecular weight binder particle, wherein the porous mass is wrapped along its longitudinal axis with a compressible wrapping material and wherein encapsulated pressure drop of the wrapping material is greater than the encapsulated pressure drop of the porous mass;

a joiner area wherein a first filter section piece and a second filter section piece are joined along their longitudinal axes;

a wrapping area wherein the first filter section piece and the second filter section piece are wrapped with a paper to form a smoking device filter; and

a conveyor to transport the smoking device filter to a subsequent area for storage or use.

136. The apparatus of claim 135, wherein the active particle comprises carbon and the porous mass has a carbon loading of at least about 6 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

137. The apparatus of claim 135, wherein the porous mass has an active particle loading of at least about 1 mg/mm and an encapsulated pressure drop of about 20 mm of water or less per mm of porous mass.

138. The apparatus of claim 135, wherein the porous mass has a void volume of about 40% to about 90%.

139. The apparatus of claim 135, wherein the active particle comprises an element selected from the group consisting of: a nano-scaled carbon particle, a carbon nanotube having at least one wall, a carbon nanohorn, a bamboo-like carbon nanostructure, a fullerene, a fullerene aggregate, graphene, a few layer graphene, oxidized graphene, an iron oxide nanoparticle, a nanoparticle, a metal nanoparticle, a gold nanoparticle, a silver nanoparticle, a metal oxide nanoparticle, an alumina nanoparticle, a magnetic nanoparticle, a paramagnetic nanoparticle, a superparamagnetic nanoparticle, a gadolinium oxide nanoparticle, a hematite nanoparticle, a magnetite nanoparticle, a gado-nanotube, an endofullerene, Gd@C60, a core-shell nanoparticle, an onionated nanoparticle, a nanoshell, an onionated iron oxide nanoparticle, and any combination thereof.

140. The apparatus of claim 135, further comprising a cutting area wherein a filter rod is cut can be used to form multiple smoking devices.

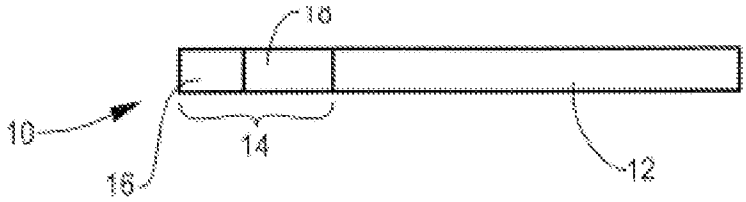

Figure 1

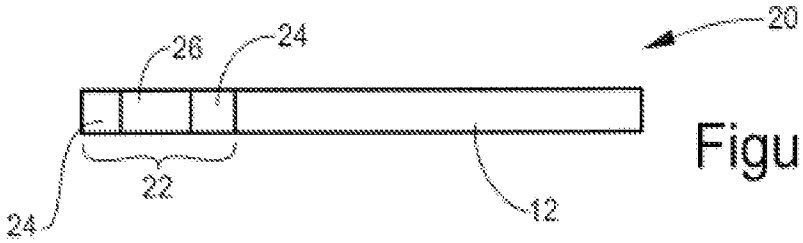

Figure 2

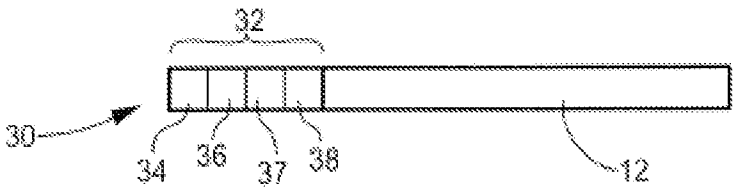

Figure 3

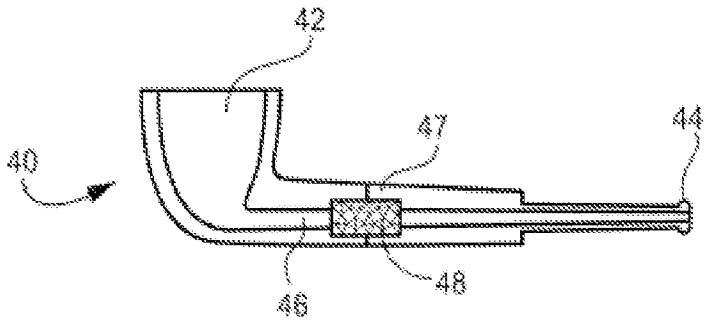

Figure 4

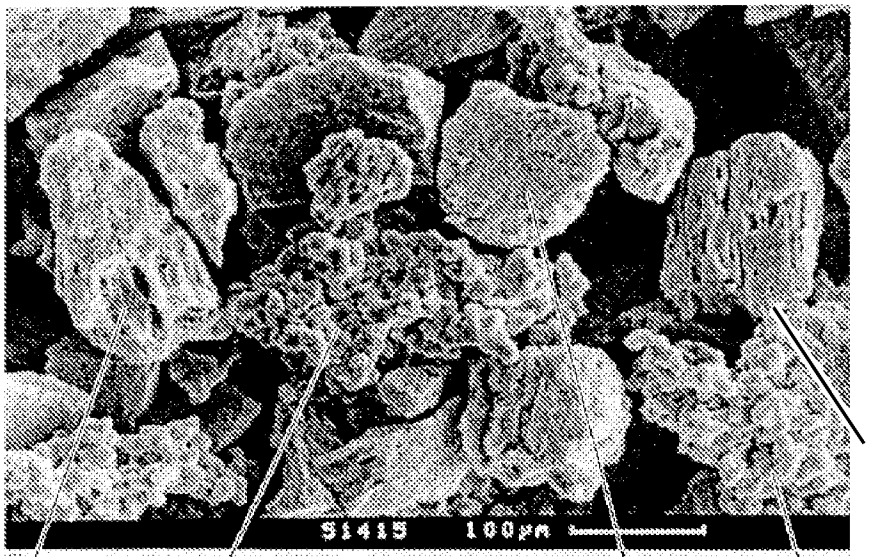

Figure 5

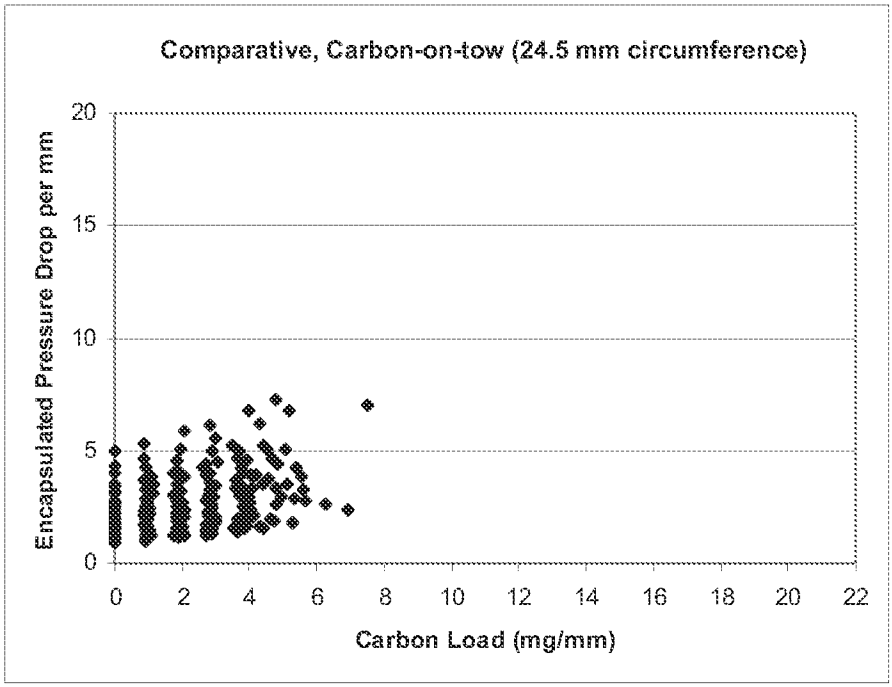
Comparative, Carbon-on-tow (24.5 mm circumference)
Encapsulated Pressure Drop per mm
0
5
10
15
20
0
2
4
6
8
10
12
14
16
18
20
22
Carbon Load (mg/mm)

Fig. 6

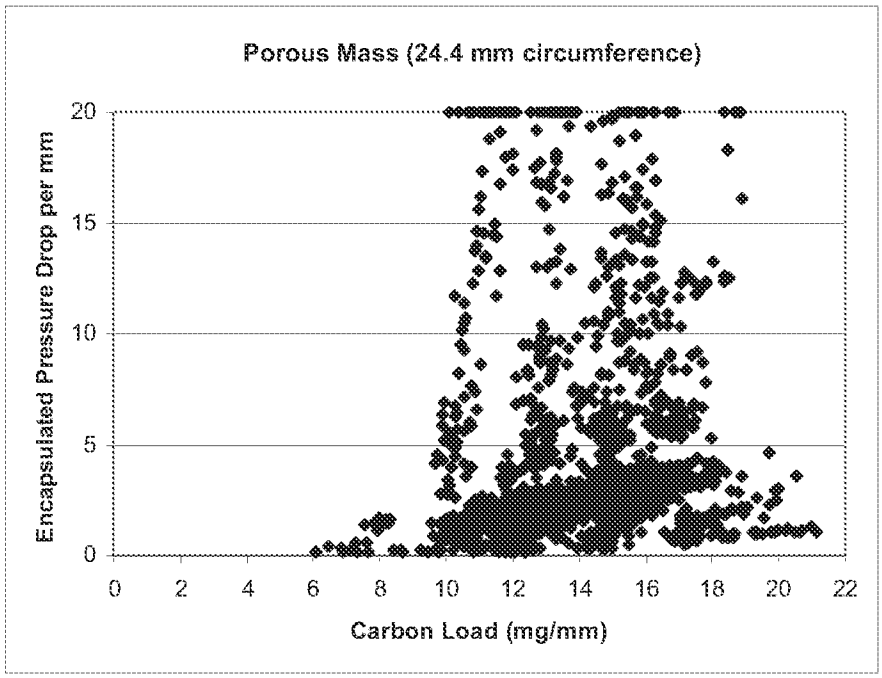
Porous Mass (24.4 mm circumference)
Encapsulated Pressure Drop per mm
0
5
10
15
20
0
2
4
6
8
10
12
14
16
18
20
22
Carbon Load (mg/mm)

Fig. 7

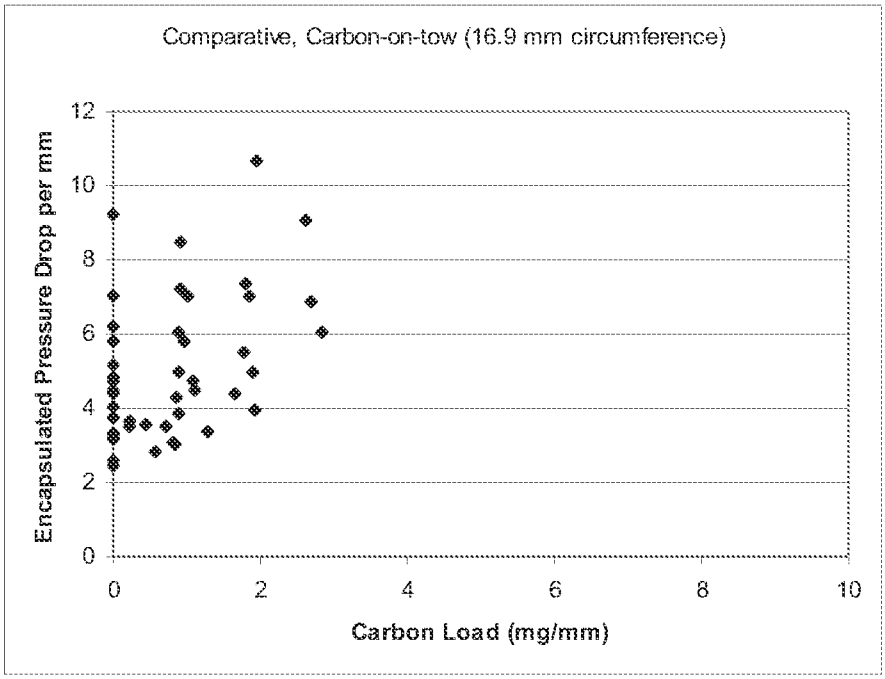
Comparative, Carbon-on-tow (16.9 mm circumference)
Encapsulated Pressure Drop per mm
0
2
4
6
8
10
12
0
2
4
6
8
10
Carbon Load (mg/mm)

Fig. 8

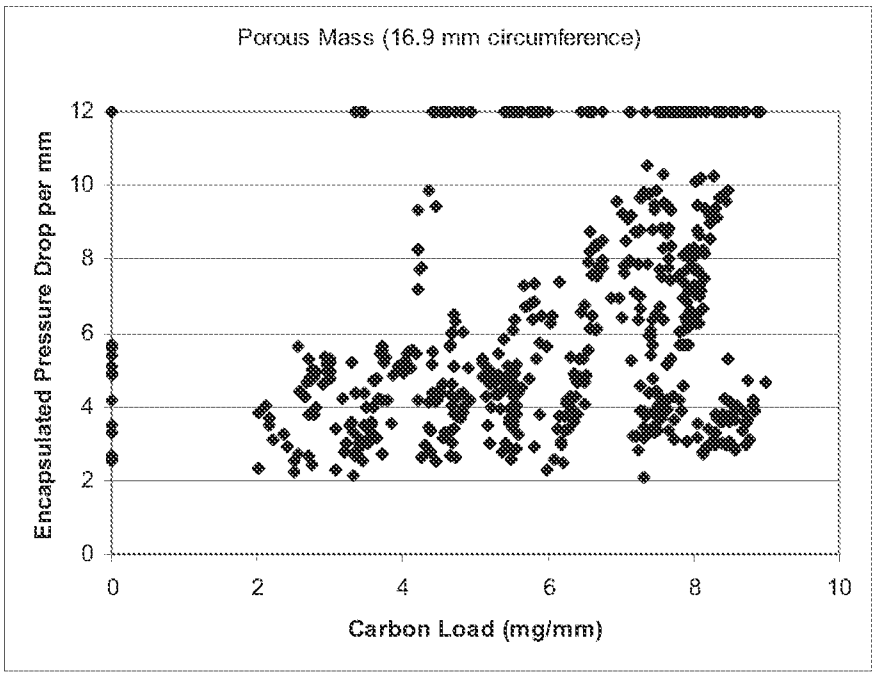
Porous Mass (16.9 mm circumference)
Encapsulated Pressure Drop per mm
0
2
4
6
8
10
12
0
2
4
6
8
10
Carbon Load (mg/mm)

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/44142

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A24D 3/06 (2011.01)
USPC - 131/331
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): A24D 3/06 (2011.01)
USPC: 131/331

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8): A24B 15/28, 15/18; A24F 13/22 (2011.01)
USPC: 131/331,332,342,260

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST;PGPB, USPT, EPAB, JPAB, GoogleScholar, Dialog
cigarette, smoking, carbon, activated, fullerene, graphene, cellulose acetate, polypropylene, void volume,melt flow etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/0173320 A1 (DUNLAP et al.) 24 July 2008 (24.07.2008) Abstract, Fig. 1, Fig. 2, Fig. 5-Fig. 8, para[0009], para[0010], para[0012], para[0015], para[0028], para[0030], para[0032], para[0034], para[0035], para[0053], para[0061], para[0063], para[0068], para[0069], para[0072], para[0074], para[0081], para[0082], para[0083], para[0093], para[0094], para[0099]	1-140
Y	US 4,807,647 A (HAYES) 28 February 1989 (28.02.1989) col 1, ln 5-15, col 1, ln 62-65, col 2, ln 5-15, col 2, ln 65-67, col 3, ln 14-17	1-140
Y	US 4,516,589 A (RAINER et al.) 14 May 1985 (14.05.1985) col 5, ln 17-20	4, 25, 39, 48, 57, 72, 81, 92, 104, 110, 118, 124, 132 and 138
Y	US 2010/0176068 A1 (DALLAS et al.) 15 July 2010 (15.07.2010) para[0033], para[0036], para[0101], para[0134]	2-3, 9-12, 16, 23-24, 40, 46-47, 55-56, 70-71, 79-80, 90-91, 102-103, 108-109, 116-117, 122-123, 130-131 and 136-137

----------CONTINUED ON NEXT SHEET----------

☒ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2011 (24.11.2011)	06 DEC 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	----------CONTINUED FROM PRIOR SHEET----------	
Y	US 2006/0086366 A1 (XUE et al.) 27 April 2006 (27.04.2006) para[0005], para[0027], Table 3	21
Y	US 6,762,139 B2 (STROMMEN) 13 July 2004 (13.07.2004) col 7, ln 10-18, col 7, ln 30-50, col 8, ln 15-30	2-3, 23-24, 41, 46-47, 55-56, 65, 70-71, 79-80, 90-91, 102-103, 108-109, 116-117, 122-123, 130-131 and 136-137
Y	US 2005/0133052 A1 (FOURNIER et al.) 23 June 2005 (23.06.2005) Abstract	113-114