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POLYOLEFIN TOW FOR CIGARETTE FILTERS

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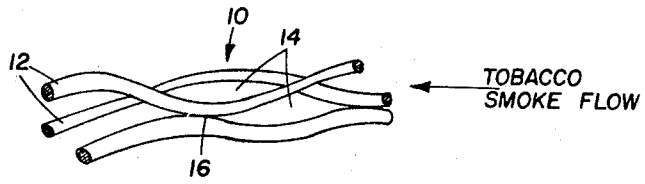

FIG. 1

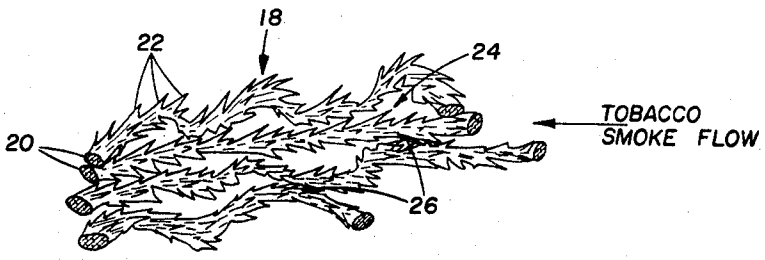

FIG. 2

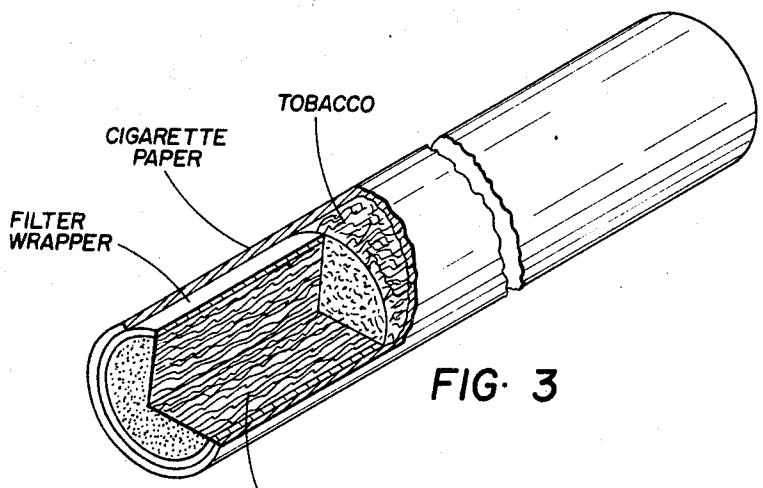

FIG. 3

POLYOLEFIN — POLYSTYRENE HIGHLY CRIMPED, FIBRILLATED, AND PLASTICIZER TREATED TOBACCO SMOKE FILTER

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POLYOLEFIN TOW FOR CIGARETTE FILTERS

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ABSTRACT OF THE DISCLOSURE

A polyolefin-polystyrene plasticizer sensitive tow material and tobacco smoke filter elements formed therefrom.

This invention relates to a tow material that is particularly useful for the manufacture of tobacco smoke filters. More particularly, this invention relates to a modified type of crimped polyolefin which, due to its plasticizer sensitivity and the structure of its filaments, is more suitable as an intermediate for the production of cigarette filters than are those heretofore known and used crimped tows made of melt spun filaments. Specifically, this invention relates to plasticizer bondable crimped filter tows the fibers of which are obtained by drafting and fibrillating a melt extruded film of polypropylene containing polystyrene as an additive, and to tobacco smoke filters made therefrom.

There exists in the vapor phase of tobacco smoke certain small, but yet highly important, quantities of various gaseous and solid compounds which exhibit a specific toxic action on the human tissue with which they come into contact. Thus in an effort to reduce or, if possible, completely eliminate the presence of these deleterious tobacco smoke constituents the tobacco industry has extensively investigated the use of various types of tobacco smoke filters. Of all these various types of tobacco smoke filters tested those made from crimped textile-like strands of cellulose acetate are by far the most widely accepted.

There are a number of reasons why cellulose acetate or other like spun fibers have enjoyed such popularity in the tobacco filter industry. For example, not only is cellulose acetate relatively inexpensive and readily available, but it can be continuously and rapidly processed into filter rods on existing commercial equipment. Another important attribute of cellulose acetate filter tow is its sensitivity to liquid, essentially nonvolatile, plasticizers. By this it is meant that during the continuous processing of the filter rods a nonvolatile, oily, liquid plasticizer such as glycerol triacetate can be added to the tow to produce a firm filter element. This firmness of the cellulose acetate filter element is produced by the plasticizer liquid gradually dissolving and bonding together adjacent fibers within the filter at random points of contact. Such a rigid filter structure can then be easily and cleanly cut into smaller segments the size of a filter tip.

The use of such a plasticizer hardening or bonding agent in producing tobacco smoke filter elements has many obvious advantages over the use of conventional adhesives of the type which make the tow tacky as soon as they are applied. For example, the use of a tacky adhesive is objectionable since they cause the rapidly moving tow to adhere to the various parts of the filter making machine. Also, the use of such conventional tacky adhesives requires the removal of water or an organic solvent from either the tow or the finished filter rod.

Of course a cellulose acetate filter tow has numerous other features which are highly desirable, if not manditory, for any tobacco smoke filter, especially those to be used on cigarettes. These additional features include being nontoxic, nonodorous, white, and stable to storage under varying conditions of humidity and temperature. However,

even in view of these many attributes, filter tow made from cellulose acetate or other like spun filamentary materials leave something to be desired in reference to their general physical characteristics. For example, these filamentary materials are inherently straight with very smooth outer surfaces. In addition to this they are relatively weak and, in the case of cellulose acetate, somewhat more expensive to produce than certain other types of synthetic materials.

It is now well known to the art of tobacco smoke filtration that a fiber which has a smooth outer surface and is inherently straight cannot successfully be used without physical modification in a filter since the fibers will lie in a more or less parallel arrangement and thus permit smoke particles to channel through its length and into the smoker's mouth. The first efforts by the industry to alleviate this basic and undesirable characteristic of such straight, smooth filamentray materials was by subjecting them to a crimping operation. This crimping operation was accomplished through the use of various methods and apparatus designed for placing any desired crimp count (defined as one-half the number of fiber bends per linear inch) into a substantially straight filamentary material. For instance, these crimps have been produced mechanically by means of intermeshing gear-like elements, by means of a "stuffer-box" type crinkler, or by twisting the fibers, setting the twist, and then untwisting. Needless to say, although this crimping operation is somewhat time consuming and adds to the over-all expense of the finished filtered product it nevertheless has been reasonably successful and is widely accepted by the industry since it not only results in the breaking up of those channels which would otherwise exist in the interstices between the fibers, but also increases the bulk factor of the fibers.

This crimping of fibrous tow materials is not, however, without its own drawbacks. Besides the added time and expense required for producing such crimped tow, these crimped tows, when made of cellulose acetate or a like material that is relatively weak, cannot have a crimp count in excess of around 12 per inch. Furthermore, the low strength of the filter tow creates special handling and processing problems while the low crimp count capability of the tow limits its bulk factor to a value below that normally desired.

In an effort to compensate for the low crimp count capability as well as to improve the filtration properties of cellulose acetate and other like fibrous filters, it was proposed that certain solid and liquid additives be applied to the tow. Certain melted waxy combinations were thus sprayed upon the spread out tow to produce a mass of discontinuous hairlike projections which extended from the otherwise smooth surface of the cellulose acetate fibers. The fact that these hairlike projections extended into the space between the fibers produced a more torturous path for the smoke particles and as a result many of the particles which would normally channel through the filter by passing between the parallel filaments were impinged on the hairlike protrusions. However, as might be imagined, the production of such fibrils on the tow is not an easy or simple task but involves the spraying of a hot melt of wax onto the moving tow. This spraying operation entails the use of an elaborate spray booth as well as a system for recovering the overspray. Furthermore, for best results this spraying operation had to be performed just prior to the processing of the tow into the filter elements. This meant that the manufacturer of the filter elements had to apply the additive to the tow which is not nearly as desirable a condition as when the manufacturer can purchase a tow which does not have to be specially treated in order to yield an effective filter.

A second and later approach taken to improve the tar removal properties of cellulose acetate tow included the

addition of certain crystallizable types of compounds to the spinning solution. These additives became a part of the spun fibers and as they gradually extruded to the surface they produced tiny protrusions which extended from the otherwise smooth fiber surface into the interstices between the fibers. However, this migration of the incorporated solid compounds to the surface of the fibers required a considerable length of time. Therefore a somewhat indefinite length of storage time was required before the solid particles started to appear on the surface of the fibers. Also, during the passage of the tow through the many parts of the filter rod making machine there was a tendency for the extruded particles to fall off or be wiped off the fibers. Furthermore, these filter tows were still inherently weak and could not be crimped to any appreciable extent without breaking.

In an effort to completely alleviate the undesirable low crimp count and bulk factor characteristics of heretofore known tow materials it has been proposed that the crimped tow be made of a melt spun polyolefin fiber. These new fibers can be made into a tow that has certain very definite advantages over a cellulose acetate type tow as a filter intermediate. For example, in addition to being potentially less expensive than a tow of cellulose acetate fibers it is considerably stronger and can, therefore, be processed to have a much higher crimp count without being rendered too weak to be processed into filter rods on existing commercial equipment. By way of example, a tow made of melt spun polyolefin fibers can be crimped to contain 30 to 40 crimps/inch and the resulting product has ample strength to permit its use in commercial filter forming equipment. By comparison, when a high degree of crimp is given to a cellulose acetate tow, i.e., 20 crimp/inch or higher, it is rendered too weak to be processed into fibers on existing commercial equipment operating at practical speeds.

Another advantage of a tow of melt spun polyolefin fibers is its hydrophobic nature. Because of this during the smoking of the tobacco product the filter shows no tendency whatsoever to become soggy or distorted because of the retention of water from the smoke or from the smoker's mouth. Also, its low moisture pickup prevents the filter from drying the smoke and thereby making it distasteful.

Although a filter tow of spun polyolefin fibers has certain advantages over a tow of cellulose acetate fibers it too has some disadvantages. These disadvantages include the fact that conventional, inexpensive high boiling plasticizers such as glycerol triacetate, triethylene glycol diacetate, diethyl phthalate, dibutyl phthalate, and the like will not fuse the fibers together at random points to produce a firm filter rod as they do in the case of cellulose acetate tow filters. This means that a difficult-to-cut, heavy paper wrap must be placed around the rod instead of the easy-to-cut, thin paper wrappers commercially used for cigarette filter rods. Or, as an alternative to the heavy paper wrapper, it means that an expensive heating step might have to be applied to the filter rods to fuse some fibers together into a rigid structure. It could also require the use of a tacky adhesive with its accompanying problems to harden the filter rods. Furthermore, these spun fibers of polyolefin have smooth surfaces which let more smoke particles channel through than would occur if the fibers contained bumps, protrusions or other fibrils extending from their surfaces.

According to this invention it has been found that a plasticizer sensitive and structurely strong tow material can be produced which forms an exceptionally good intermediate for the production of tobacco smoke filters. This new and novel material is obtained by drafting and fibrillating a melt extruded film of polypropylene containing a polystyrene additive. The ribbon-like, flat fibrous material thus produced is easily formed into a filter element on standard equipment operated in a conventional manner to give a tobacco smoke filter having very high tar and nicotine removable capabilities.

Therefore, an object of this invention is to produce a new and improved polyolefin type of crimped tow which can be used as a tobacco smoke filter intermediate.

Another object of this invention is to disclose a plasticizer sensitive and structurely strong polyolefin type material that can be used to produce a filter tow having an extremely high crimp count.

Yet another object of this invention is to disclose a highly crimped polyolefin tow, the filaments of which contain tiny hairlike splinters or fibrils which are firmly attached to and form an integral part of the filaments.

A further object of this invention is to disclose a polyolefin tow that can be highly crimped, fibrillated and treated with high boiling, oily plasticizers to give a firm cigarette filter.

A still further object of this invention is to disclose an inexpensive cigarette filter that is formed from a highly crimped, fibrillated and plasticized treated polyolefin tow which is very effective for the removal of the tar and nicotine found in the effluent stream of tobacco smoke.

These and other objects and advantages of this invention will be more apparent upon reference to the following description, appended claims, specific working examples, and drawings wherein:

FIGURE 1 is a diagrammatic illustration on an enlarged scale of a bundle of smooth surface filaments such as cellulose acetate;

FIGURE 2 is a diagrammatic illustration on an enlarged scale of a bundle of fibrillated and bonded polyolefin-polystyrene filaments made in accordance with this invention; and

FIGURE 3 illustrates a cigarette having attached to the tip thereof a tobacco smoke filter made from fibrillated and bonded polyolefin-polystyrene filaments.

With continued reference to the accompanying figures and with initial attention directed to FIGURE 1, reference numeral **10** is used to generally designate a bundle of crimped cellulose acetate fibers. As will be noted, the outer surface of each fiber **12** is substantially smooth and thus large channels or openings **14** exists between the various fibers through which the tobacco smoke may pass without encountering any filtering action. For purposes of illustration the fibers are shown bonded together at **16** by a suitable high boiling, oily plasticizer.

FIGURE 2 illustrates a bundle **18** of fibers taken from a highly crimped filter tow formed in accordance with this invention from a multiplicity of highly fibrillated continuous fibers composed of from 40 to 70 percent poly-α-olefins and from 60 to 30 percent polystyrene. As will be observed, the individual filaments **20** of this type tow are entirely different in appearance from the smooth surfaced, substantially rounded filaments **12** of FIGURE 1 which were obtained from a conventional wet, dry, or melt spinning process. This highly important difference is that the polyolefin-polystyrene fibers **20** are flat and ribbon-like in appearance with a thickness of from 15 to 100 microns which permits them to be fibrillated to produce the desired results. Since the fibers **20** are fractured during their preparation, numerous fine hairlike fibrils **22** of varying thickness and length will be produced annd will extend from their surface in all directions. As can be seen, these fine splinter fibrils **22**, which have a thickness from about 0.5 micron to about 15 microns, extend into the spaces **24** that exist between the various fibers **20** and therefore allow less of the solid tobacco smoke constituents carried in the effluent stream of smoke to pass therethrough. This coupled with the fact that these fine fibrils **22** are uniformly dispersed between the coarser trunk or continuous portion of the fibers **20** is believed to be the reason why filters formed from this novel tow can remove a higher percentage of the smoke particles (tar) found in cigarette smoke than other similar heretofore known filter materials without at the same time pro-

ducing such a high pressure drop (resistance to draw) that they would be impractical for use on cigarettes. Furthermore, since these hairlike protruding fibrils **22** are firmly attached by one end to the larger trunk portions of the filament and are, therefore, an integral part of the main ribbon-like filaments **20** they do not fall off nor can they be wiped off as the tow **18** passes through the many parts of the cigarette filter rod making machine.

The filaments **20** may be fibrillated to the point that the splinter or fibril filaments **22** represent from 10 to 70 percent of the total make-up of the crimped filter tow **18**. Below this value of fibrillation there are not enough of these fine fibrils in the tow to render it very effective as a filter material while above this value the main continuous trunk portion of the filaments **20** is so reduced in size as to substantially weaken the tow thereby making it too weak to be processed into filter rods on standard equipment. The preferred ratio of fibrillation of the tow has been found to be 20 to 50 percent splinted fibrils and 50 to 80 percent ribbon-like filaments. The total number of "filaments" in the filter tow, which includes both the ribbon-like filaments **20** and fibrils **22**, can vary over a wide range since their thickness can vary from 0.5 to about 15 microns for the fibril type to over 100 microns for the heavier ribbon-like type. Therefore, in terms of total denier it can be said that the tow **18** may vary from about 20,000 total denier to 150,000 total denier.

As is well known, polyolefin fibers per se cannot be bonded together with a high boiling, oily plasticizer. Thus, to avoid the use of tacky adhesives the filaments **20** were made plasticizer sensitive by placing at least 30 percent by weight of polystyrene in the polyolefin spinning dope. Because of the presence of the plasticizer-soluble polymer in the melt spun polyolefin filaments **20**, the tow **18** is rendered plasticizer sensitive and can be bonded together by a plasticizer as illustrated at **26** in FIGURE 2. As will be appreciated by those working in the filter art, this capability of the polyolefin-polystyrene filter material of this invention is of utmost importance. The percentage of polystyrene added is somewhat critical with the optimum amount of polystyrene additive having been found to be between 35 and 50 percent by weight. Lower amounts of polystyrene give a filter tow that cannot be hardened by the application of a plasticizer while, conversely, too much polystyrene (over 60 percent) makes the tow too weak to withstand the tension applied to it during the filter rod making process.

The type of polyolefin in the mixture of polyolefin and styrene from which the filaments of the tow are made can be any of the film-forming types with molecular weights from about 10,000 to 900,000. Preferably the molecular weight should be between 25,000 and 200,000. Their softening points should be between 70° C. and 160° C. Of the several polyolefin materials produced industrially the preferred ones are polyethylene and polypropylene or copolymers of ethylene and propylene.

Concerning the polystyrene, it can have a molecular weight of from 5,000 to 500,000; the preferred range in molecular weight being from 10,000 to 100,000. The softening point of the polystyrene should fall between 100° C. and 160° C., and preferably between 130° C. and 150° C. Both polymers may contain substituent groupings providing such groupings do not change the softening points beyond those stipulated.

The fibrillated filaments from which this novel filter tow is made can be produced by any of the known techniques for fracturing elongated polymeric strands so that splinter type fibrils extend from them. However, the preferred technique is the one disclosed in pending application 446,059, filed Apr. 6, 1965, and assigned to the same assignee as this invention. This method fibrillating ribbon-like filaments is simple, economical, and can be carried out in one continuous operation. For example, a blend of the polyolefin and the polystyrene is melt extruded into a film which is then continuously drafted and fibrillated into fractured, ribbon-like filaments. A number of these filaments are gathered together to produce the tow of this invention.

For best results the polyolefin-polystyrene filter tow should be crimped. The number of crimps placed in filter tow **18** should be sufficiently high to raise the bulk factor of the tow to the point where it fills out the cigarette filter rod. This crimp value has been found to be between 15 and 50 crimps/inch with the preferred number of crimps being between 20 and 30. These crimps can be applied to the tow by any suitable method such as a conventional "stuffer box" crimping device known in the textile art.

A further understanding of the invention will be had from a consideration of the following examples that may be used in actual commercial practice and are set forth to illustrate certain preferred embodiments.

Example 1

Highly fibrillated filaments formed from a melt extruded film of 50 percent polypropylene (mol. wt. 32,000) and 50 percent polystyrene (mol. wt. 10,000) were prepared according to the procedures given in the aforementioned application Ser. No. 446,059. Microscopic examination of the filaments indicated that there were many tiny hairlike projections extended outwardly from the larger trunk portion of the continuous filaments and that these fibrils had a thickness of from 1 to 10 microns. A 250-ft. length of tow of 60,000 total denier was produced from these filaments and was given 30 crimps/inch through the use of a stuffer box. The crimped tow was then processed into filter rods (25.4 mm. circumference) on a machine similar to the one disclosed in the Crawford-Stevens U.S. Patents 2,794,239 and 2,794,480. During the passage of the tow through the machine it was opened or bloomed out at one point and sprayed with diethyl phthalate. The plasticizer treated and paper (cigarette paper) wrapped rods contained 10 percent diethyl phthalate; after 60 minutes they had sufficient rigidity so that they could be cleanly cut into 15 mm. filter segments.

Several of these filters were attached to standard cigarettes which had been 85 mm. in length but which were shortened to 70 mm. to compensate for the length of the filters. These filter cigarettes (now 85 mm.) were smoked to 35 mm. butt lengths on an automatic smoking machine. The weight percentage of smoke particles (tar) removed by the filters is shown in Table 1. This method of smoking filter cigarettes and determining the efficiency of their filters (percent smoke solids or "tar" removed) is described by W. V. McConnell, R. C. Mumpower, and G. P. Touey in "Tobacco Science," vol. 4, pp. 55–61 (1960). The pressure drops (resistance to draw) of the filters were also obtained and the average value was calculated (Table 1). The method for determining pressure drop in inches of water at an air flow rate of 17.5 ml./sec. is described by G. P. Touey in Anal. Chem., vol. 27, pp. 1788–1790 (1955).

For comparison, there is also listed in Table 1 the results obtained from a 15 mm. filter prepared from a crimped tow of 20,000 smooth-surfaced filaments, these filaments having been melt spun from the same blend of polymers used in producing the fibrillated filaments. The conditions for preparing the tow for this control filter are reported in Example 2 of U.S. Patent 3,038,478.

TABLE 1

Filter (15 mm.)	Average Pressure Drop of Ten Filters (inches H_2O)	Percent* Tar Removed
Fibrillated filaments of polypropylene and polystyrene	2.1	44
Melt spun smooth surfaced filaments of polypropylene and polystyrene	2.0	34

*The term "tar" signifies the liquid-solid particles of cigarette smoke. Since it is known that the nicotine is an integral part of these particles a filter which removes particles by impingement removes the same percentage or amount of nicotine as "tar".

Example 2

Highly fibrillated filaments formed from a melt extruded film of 65 percent polyethylene (mol. wt. 42,000) and 35 percent polystyrene (mol. wt. 12,500) were prepared according to the procedure disclosed in application Ser. No. 446,059. A 200-ft. crimped (25 crimps/inch) tow of 65,000 total denier was prepared from these filaments which consisted of about 35 percent of the fibril type and 65 percent of the heavier and parallel type. During the passage of the two through the cigarette filter rod making machine it was bloomed out at one point and sprayed with dibutyl phthalate. The plasticizer treated and cigarette paper wrapped rods contained 8 percent plasticizer. About 45 minutes after the filter rods were made they were firm enough to be cleanly cut into 15 mm. filter tip segments.

Several of these filter tips were tested for pressure drop and for their effectiveness in removing tar from cigarette smoke in the manner described in Example 1. The results obtained are listed in Table 2. Commercial 15 mm. filters made from a tow of cellulose acetate fibers (5 den./fil.) were also tested for pressure drop and for their effectiveness in removing tar from cigarette smoke. For comparative purposes these results are also listed in Table 2.

TABLE 2

Filter (15 mm.)	Average Pressure Drop of Ten Filters (inches H_2O)	Percent Tar Removed
Fibrillated filaments of polyethylene and polystyrene	2.0	41
Commercial cellulose acetate filter of 5 denier/filament fibers	2.0	25

Example 3

Highly fibrillated filaments formed from a melt extruded film of 45 percent polypropylene (mol. wt. 60,000) 55 percent polystyrene (mol. wt. 15,000) were prepared according to the procedure disclosed in application Ser. No. 446,059. A 200-ft. crimped tow (30 crimps per inch) of 70,000 total denier was prepared from these filaments which consisted of about 50 percent the fibril type and 50 percent the heavier parallel type. During the passage of the tow through the rod making machine it was bloomed out at one point and treated with 10 percent di-(2-ethylhexyl) phthalate by means of a wicking device which wiped the plasticizer on the filaments. The final paper wrapped filter rods were firm enough to be cleanly cut into small 15 mm. filter segments about 1 hour after they were prepared.

Several of these filter tips were tested for pressure drop and for their effectiveness in removing tar from cigarette smoke in the manner described in Example 1. A 15 mm. commercial filter of cellulose acetate (1.6 denier/filament fibers) was tested in a similar manner. The results shown in Table 3 indicate that a filter of the finest commercially available cellulose acetate fibers is still not quite as effective as one which can be prepared from the inexpensive and novel tows disclosed in this invention.

TABLE 3

Filter (15 mm.)	Average Pressure Drop of Ten Filters (inches H_2O)	Percent Tar Removal
Fibrillated filaments of polypropylene and polystyrene	3.5	55
Commercial cellulose acetate filter of 1.6 denier/filament fibers	3.4	50

From the foregoing it is readily apparent that the highly-crimped, fibrillated, plasticizer sensitive polyolefin-polystyrene filter tow of this invention offers numerous advantages over those tows heretofore known and used to produce tobacco smoke filter elements. For example, not only is the tow easily bonded by known and commercially acceptable plasticizer, thus alleviating the need for using heavy wrapper papers or tacky adhesives, but the polyolefin-polystyrene, ribbon-like filaments are strong enough to permit high fibrillation and easy processing in existing commercial equipment. This high degree of fibrillation results in a more effective tar and nicotine filter than was heretofore thought possible. Furthermore, not only are the filaments less expensive to produce than conventional cellulose acetate type fibers, but the high fibrillation and extremely high crimp count that can be placed in the new filaments greatly increases the bulk factor of a filter tow made from the fibers. The desirable ramifications of this high bulk factor, including the fact that with a higher crimp level less fibers of a given denier/filament are required to fill out the filter element to its proper size, is readily apparent to those working in the filter tow art. The other advantages of the new polyolefin-polystyrene tow, such as its low moisture retention characteristic and ease of production to name only a few, will also be appreciated by those working in the field.

This invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. As an article of manufacture, a filamentary bundle-like product useful for the manufacture of tobacco smoke filter elements, said product comprising a plurality of highly crimped, continuous filaments which are arranged substantially parallel to one-another to form a tow band, said filaments being composed of from 40 to 70 percent of a polyolefin having a molecular weight from about 10,000 to 900,000 with a softening point between 70° C. and 160° C. uniformly mixed with from 60 to 30 percent of a polystyrene having a molecular weight from about 5,000 to 500,000 with a softening point between 100° C. and 160° C., the new product being particularly characterized in that the filaments thereof are ribbon-like in appearance with a thickness of from about 15 to 100 microns, are highly fibrillated so that fine splinter fibrils having a thickness of between about 0.5 micron and about 15 microns extend therefrom, and are readily bondable together at points of contact by a plasticizer.

2. The product in accordance with claim 1 wherein said fibrillated filaments are composed of 50 to 65 percent of polyolefin and 50 to 35 percent of polystyrene.

3. The product in accordance with claim 1 wherein the molecular weight of the polyolefin falls between about 25,000 and 200,000, and the molecular weight of the polystyrene falls between about 10,000 and 100,000 with the softening point of the polystyrene being between 130° C. and 150° C.

4. The product in accordance with claim 1, wherein the polyolefin is selected from the group consisting of polypropylene and polyethylene.

5. The product in accordance with claim 1 wherein the total denier of tow falls between about 20,000 and 150,000.

6. The product in accordance with claim 1, wherein the tow has a crimp count between about 15 and 50 crimps per inch.

7. The product in accordance with claim 6 wherein the crimp count is between 20 and 30 crimps per inch.

8. The product in accordance with claim 1 wherein said fine splinter fibrils represent from about 10 to 70 percent of the total number of filaments in the tow.

9. The product in accordance with claim 8 wherein said fine splinter fibrils represent from about 20 to 50 percent of the total number of filaments in the tow.

10. A tobacco smoke filter element comprised of highly crimped, continuous filaments extending generally longitudinally of the filter element, said filaments being composed of from 40 to 70 percent of a polyolefin having a molecular weight from about 10,000 to 900,000 with a softening point between 70° C. and 160° C. uniformly mixed with from 60 to 30 percent of a polystyrene having a molecular weight from about 5,000 to 500,000 with a softening point between 100° C. and 160° C., the filter element being particularly characterized in that the filaments thereof are (1) ribbon-like in appearance with a thickness of from about 15 to 100 microns (2) are highly fibrillated so that fine splinter fibrils having a thickness of between about 0.5 micron and about 15 microns extend therefrom, and (3) are bonded together at random points by a plasticizer.

11. The tobacco smoke filter according to claim 10 wherein said filaments have between about 15 and 50 crimps per inch.

12. The tobacco smoke filter according to claim 11 wherein said fine splinter fibrils represents from about 10 to 70 percent of the total number of filaments in the filter.

13. The tobacco smoke filter according to claim 12 wherein said filaments are produced by fibrillating a melt extruded film of a polypropylene containing 35 to 50 percent of a polystyrene.

14. The tobacco smoke filter according to claim 13 wherein the total denier of the filter is between about 20,000 and 150,000.

15. The tobacco smoke filter according to claim 12 wherein said filaments are produced by fibrillating a melt-extruded film of a polyethylene containing 35 to 50 percent of a polystyrene.

16. The tobacco smoke filter according to claim 12 wherein said filaments are produced by fibrillating a melt-extruded film of a coplymer of ethylene containing 35 to 50 percent of a polystyrene.

17. The tobacco smoke filter according to claim 12 wherein said filaments are produced by fibrillating a melt-extruded film of a copolymer of propylene containing 35 to 50 percent polystyrene.

18. The tobacco smoke filter according to claim 10 wherein the polyolefin has a molecular weight from 25,000 to 200,000.

19. A tobacco smoke filter according to claim 10 wherein the polystyrene has a molecular weight from 10,000 to 100,000.

20. The tobacco smoke filter according to claim 10 wherein the polystyrene has a softening point between 130° C. and 150° C.

21. The tobacco smoke filter according to claim 10 wherein the plasticizer is of the high boiling, oily type.

22. The tobacco smoke filter according to claim 10 wherein the plasticizer is selected from the group consisting of diethyl phthalate, dibutyl phthalate, and di-(2-ethyl hexyl) phthalate.

23. The tobacco smoke filter according to claim 12 wherein said fine splinter fibrils represent from about 20 to 50 percent of the total number of filaments in the filter.

24. The tobacco smoke filter according to claim 10 wherein the total denier of the filter is between about 20,000 and 150,000.

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