Articiles with improved flame retardancy and/or melt dripping properties have been disclosed. Reduced melt dripping can prevent injuries. Methods for making and using such compositions, articles and fabric are disclosed.
Published: 
— with international search report (Art. 21(3))


(88) Date of publication of the international search report:
1 October 2015
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC (8) - C08K 3/28; C09K 21/12; D01F 1/07 (2015.01)
CPC - C26K 3/26; C08K 21/12; D01F 1/07

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) - C08K 3/28; C09K 21/12; D01F 1/07; D03D 15/12 (2015.01)
CPC - C08K 3/28; C08K 21/12; D01F1/07; D03D15/12; D10B2331/021; Y10S250/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
Patent (US, EP, WO, JP, DE, GB, CN, FR, KOR, ES, AU, IN, CA, INPADOC Data); Google/Google Scholar; ProQuest; IP.com; fabric, textile, cloth, woven, react, foam, crosslink, fiber, fibre, form, flame, fire, heat, expose, apply, amine, hydroxyl, resistant, retardant, acid, exopolysaccharide, [010]14, [1H]1t, a[1]2sulfonate, thiol, hydroxyl, acid, functionalized, nanoparticle, silica,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 4,147,744 A (SLAMA, Fj et al.) April 3, 1979; abstract; column 1, lines 22-25, 40-55; column 2, lines 43-44; column 4, lines 1-5, 12-13; column 6, lines 20-30</td>
<td>1-3, 8, 15, 20, 25, 32-45, 9-29, 43-57</td>
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<td>Y</td>
<td>US 2005/022921 A1 (BAUER, M et al.) October 5, 2006; abstract; paragraphs [0007], [0013], [0025]-[0026]; table 1</td>
<td>32-34, 38-40, 46</td>
</tr>
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<td>X</td>
<td>C1N 103073749 A (SUIZHOU ANHONGTAI NEW MATERIAL CO LTD) May 1, 2013; abstract; claim 1; paragraphs [0003], [0008], [0016], [0034]</td>
<td>32, 35-38, 41-47</td>
</tr>
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<td>Y</td>
<td>US 2,005/014875 A1 (KNOOP, S et al.) January 20, 2005; paragraphs [0019], [0046], [0054], [0070], [0073]</td>
<td>4-6, 24-25</td>
</tr>
<tr>
<td>Y</td>
<td>US 2006/0035555 A1 (NARAYANAN, V et al.) February 16, 2006; abstract; paragraphs [0200][0222], [0043]</td>
<td>10-14, 16-30</td>
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<tr>
<td>Y</td>
<td>US 2010/0075567 A1 (SCHWEIGK, S et al.) March 25, 2010; abstract; figure 3; paragraphs [0034], [0050], [0054], [0064], claim 29</td>
<td>17-18, 43-57</td>
</tr>
<tr>
<td>Y</td>
<td>US 2012/0108710 A1 (SCHWEIGK, S et al.) May 3, 2012; paragraphs 0026]-[0040], [0015], [0123], [0130]-[0131]; Claim 2</td>
<td>29, 57</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search
3 June 2015 (03.05.2015)

Date of mailing of the international search report
06 July 2015 (05.07.2015)

Name and mailing address of the ISA/Authorized officer
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450
Facsimile No., 571-273-3201

Shane Thomas
PCT Helpdesk 571-273-460
PCT O6P 571-273-7774

Form PCT/SA/210 (second sheet) (January 2015)
INTERNATIONAL SEARCH REPORT

**Box No. II** Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III** Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This international Searching Authority found multiple inventions in this international application, as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-31 and 43-57 are directed toward a polymer fabric made from reactive polymers that crosslink upon exposure to flame.

Group II: Claims 32-47 are directed toward a flame retardant article comprising an phosphate based conjugate dispersed in a polymer matrix.

---Continued Within the Next Supplemental Box---

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

□ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

□ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

□ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (January 2015)
# INTERNATIONAL SEARCH REPORT

## DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 2002/0124544 A1 [LAND, FJ et al.] September 12, 2002; figure 1; paragraphs [0003], [0006], [0034-0035], [0040]</td>
<td>16, 49</td>
</tr>
<tr>
<td>Y</td>
<td>US 4,298,509 A (FOCHESATO, A) November 3, 1981; column 1, lines 19-31, 38-40</td>
<td>38-40, 26</td>
</tr>
</tbody>
</table>
The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical features of Group I include a composition, and fabric, comprising: a first polymer functionalized with a first functional group; and a second polymer functionalized with a second functional group, the second function group being different from and complementary to the first functional group; wherein the first polymer and the second polymer are configured to form a third polymer via crosslinking upon exposure to flame; and a method of weaving fibers together to form the fabric, which are not present in Group II; and the special technical features of Group II include a flame retardant article comprising: an anchor molecule; a phosphate based flame retardant chemically joined to a reactive functional group of the anchor molecule forming a conjugate; and a polymer matrix, the conjugate dispersed in the polymer matrix, and where the anchor molecule is a nanoparticle, which are not present in Group I.

The common technical features of Groups III are a flame retardant material comprising polymers joined by chemical reaction.

These common technical features are disclosed by US 4,147,741 A to Slama et al., (hereinafter 'Slama'). Slama discloses a flame retardant material comprising polymers (fire retardant polypropylene compositions; abstract) joined by chemical reaction (fire retardant polypropylene compositions comprising a polypropylene component chemically modified by reaction with an unsaturated carboxylic acid, a polyfunctions cross-linking agent; abstract; column 1, lines 6-12).

Since the common technical features are previously disclosed by Slama, these common features are not special and so Groups III lack unity.