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(71) Applicant: **3M INNOVATIVE PROPERTIES COMPANY** [US/US]; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(72) Inventors: **ELGIMIABI, Sohaib**; Carl-Schurz-Strasse 1, D-41453 Neuss (DE). **HARRISON, Peter J.**; 3M Center, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

(74) Agents: **DAHL, Philip Y.** et al.; 3M Center, Office of Intellectual Property Counsel, Post Office Box 33427, Saint Paul, Minnesota 55133-3427 (US).

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(54) Title: FILM ADHESIVE

(57) Abstract: Curable compositions are provided which comprise: a) 30-80 wt% of a room temperature liquid epoxy resin; b) 0.5-10 wt% of an epoxy curative; c) 5-40 wt% of a thermoplastic resin; and d) 0.5-10 wt% of a physical blowing agent. In some embodiments, the curable compositions may be fire retardant. In some embodiments, the curable compositions may be used in the form of films, and more particularly as core splice film adhesives.

Film Adhesive

Field of the Disclosure

This disclosure relates to curable compositions including room temperature liquid epoxy resin, epoxy curative, thermoplastic resin, and a physical blowing agent which are, in some embodiments, useful as core splice film adhesives.

Summary of the Disclosure

Briefly, the present disclosure provides a curable composition comprising: a) 30-80 wt% of a room temperature liquid epoxy resin; b) 0.5-10 wt% of an epoxy curative; c) 5-40 wt% of a thermoplastic resin; and d) 0.5-10 wt% of a physical blowing agent. In some embodiments, the curable composition contains no epoxy resin other than room temperature liquid epoxy resin. In some embodiments, the curable composition contains an epoxy/reactive diluent room temperature liquid epoxy resin. In some embodiments, the curable composition contains a mixture of a neat room temperature liquid epoxy resin and an epoxy/reactive diluent room temperature liquid epoxy resin. In some embodiments, the curable composition contains 40-60 wt% of the room temperature liquid epoxy resin. In some embodiments, the thermoplastic resin has a softening point of between 60 °C and 150 °C, as measured by DIN EN ISO 306 method A50. In some embodiments, the thermoplastic resin is a polymer comprising phenylene oxide (-Ph-O-) units in its polymer backbone. In some embodiments, the thermoplastic resin is a copolymer of bisphenol a and epichlorhydrin. In some embodiments, the thermoplastic resin is a polyethersulfone. In some embodiments, the curable composition contains 16-25 wt% of the thermoplastic resin. In some embodiments, the curable composition additionally comprises 10-20 wt% flame retardants. In some embodiments, the curable composition additionally comprises greater than 5 wt% of an intumescent graphite flame retardant and greater than 7 wt% of a red phosphorus flame retardant. In some embodiments, the curable composition demonstrates expansion upon cure of greater than 250%. In some embodiments, the curable composition cures to a composition that is fire retardant. In some embodiments, the curable composition contains no blowing agent other than a physical blowing agent.

In another aspect, the present disclosure provides a film of the curable composition of the present disclosure. In some embodiments, the film has a thickness of less than 2 mm.

In another aspect, the present disclosure provides a cured composition obtained by curing the curable composition of the present disclosure. In some embodiments, the cured composition is fire retardant.

All scientific and technical terms used herein have meanings commonly used in the art unless otherwise specified.

As used in this specification and the appended claims, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise.

As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

As used herein, "have", "having", "include", "including", "comprise", "comprising" or the like are used in their open ended sense, and generally mean "including, but not limited to." It will be understood that the terms "consisting of" and "consisting essentially of" are subsumed in the term "comprising," and the like.

Detailed Description

The present disclosure provides an adhesive composition. In some embodiments the adhesive composition is a heat-curable adhesive composition. In some embodiments the adhesive composition is an expandable heat-curable adhesive composition. In some embodiments, the adhesive composition is in the form of a film. In some embodiments, the adhesive composition is in the form of a tape. Typically such a film or tape has a thickness of greater than 0.01 mm, more typically greater than 0.1 mm, and more typically greater than 0.5 mm. Typically such a film or tape has a thickness of less than 20 mm, more typically less than 10 mm, and more typically less than 5 mm.

The adhesive composition according to the present disclosure comprises:

a) 30-80 wt% of a room temperature liquid epoxy resin;

b) 0.5-10 wt% of an epoxy curative;

c) 5-40 wt% of a thermoplastic resin; and

d) 0.5-10 wt% of a physical blowing agent.

Any suitable room temperature liquid epoxy resin may be used in the composition of the present disclosure. In some embodiments, the liquid epoxy resin is a neat room temperature liquid epoxy resin, i.e., is a liquid at room temperature without addition of solvents or reactive diluents. In some embodiments, the liquid epoxy resin is an epoxy resin mixed with a reactive diluent such that it is a liquid at room temperature, i.e., an epoxy/reactive diluent room temperature liquid epoxy resin. In some embodiments, the adhesive composition contains no epoxy resin other than room temperature liquid epoxy resin. In some embodiments, the adhesive composition contains no epoxy resin other than neat room temperature liquid epoxy resin. In some embodiments, the adhesive composition contains no epoxy resin other than epoxy/reactive diluent room temperature liquid epoxy resin. Suitable room temperature liquid epoxy resins for use as a neat room temperature liquid epoxy resin may include bisphenol-A polyepoxide resins such as EPON 828 (Momentive Specialty Chemicals, Columbus, Ohio); D.E.R 331 (Dow Chemical Company, Midland, Michigan); bisphenol-A/F polyepoxide resins such as EPON 232 (Momentive Specialty Chemicals, Columbus, Ohio). Suitable epoxy/diluent combinations for use as epoxy/reactive diluent room temperature liquid epoxy resin may include epoxy novolac resins such as D.E.N. 438 (Dow Chemical Company, Midland, Michigan) combined with 1,4-Cyclohexandimethanoldiglycidylether; D.E.N. 431, D.E.N. 425 (Dow Chemical Company, Midland, Michigan), Epalloy 9000, Epalloy 8350 (CVC thermoset specialties, Moorestown, New Jersey).

In some embodiments, the adhesive composition comprises greater than 35 wt% room temperature liquid epoxy resin, in some embodiments greater than 40 wt% room temperature liquid epoxy resin, and in some embodiments greater than 45 wt% room temperature liquid epoxy resin. In some embodiments, the adhesive composition comprises less than 75 wt% room temperature liquid epoxy resin, in some embodiments less than 70 wt% room temperature liquid epoxy resin, in some embodiments less than 65 wt% room temperature liquid epoxy resin, in some embodiments less than 50 wt% room temperature liquid epoxy resin, and in some embodiments less than 55 wt% room temperature liquid epoxy resin.

Any suitable thermoplastic resin may be used in the composition of the present disclosure. Typically, the thermoplastic resin has a softening point of between 60 °C and 150 °C, as measured by DIN EN ISO 306 method A50. In some embodiments, the thermoplastic resin has a softening point of less than 150 °C, in some embodiments less than 135 °C, in some embodiments less than 120 °C, in some embodiments less than 105 °C, and in some embodiments less than 95 °C. In some embodiments, the thermoplastic resin has a softening point of greater than 60 °C, in some embodiments greater than 70 °C, and in some embodiments greater than 80 °C. Typically, the thermoplastic resin is a polymer comprising phenylene oxide (-Ph-O-) units in its polymer backbone. In some embodiments, the thermoplastic resin is a phenoxy resin. In some embodiments, the thermoplastic resin is a copolymer of bisphenol a and epichlorhydrin. In some embodiments the thermoplastic resin is a polyethersulfone.

In some embodiments, the adhesive composition comprises greater than 10 wt% thermoplastic resin, in some embodiments greater than 16 wt% thermoplastic resin, and in some embodiments greater than 18 wt% thermoplastic resin. In some embodiments, the adhesive composition comprises less than 35 wt% thermoplastic resin, in some embodiments less than 30 wt% thermoplastic resin, and in some embodiments less than 25 wt% thermoplastic resin.

Any suitable physical blowing agent may be used in the composition of the present disclosure. In some embodiments, the adhesive composition contains no blowing agents other than physical blowing agents, so that the resulting thermoexpanded foam is a closed cell foam. Suitable physical blowing agents may include thermoexpandable microcapsules such as those obtainable under the trade designation MICROPEARL F48D (Lehmann & Voss & Co. KG, Hamburg, Germany); MICROPEARL F30 (Lehmann & Voss & Co. KG, Hamburg, Germany) or EXPANCEL (AkzoNobel, Sundsvall, Sweden).

In some embodiments, the adhesive composition comprises greater than 0.3 wt% physical blowing agent, in some embodiments greater than 0.6 wt% physical blowing agent, in some embodiments greater than 1 wt% physical blowing agent, in some embodiments greater than 1.5 wt% physical blowing agent, and in some embodiments greater than 5 wt% physical blowing agent. In some embodiments, the adhesive composition comprises less than 8 wt% physical blowing agent, in some

embodiments less than 5 wt% physical blowing agent, and in some embodiments less than 2 wt% physical blowing agent.

Any suitable epoxy curative may be used. Typically a heat activated curative is used. Suitable curatives may include dicyandiamide curing agents; polyamine curing agents, acid anhydride curing agents, guanidine curing agents, mercaptan curing agents and phenol curing agents. Most typically the curative is a dicyandiamide curing agent.

In some embodiments, the composition additionally comprises 0.5-10 wt% of an epoxy cure accelerator. Any suitable cure accelerator may be used. Suitable cure accelerators may include aromatic substituted ureas; aliphatic and aromatic tertiary amines such as dimethylaminopropylamine; pyridine; boron complexes, including boron complexes with monoethanolamine; and imidazoles such as 2-ethyl-methylimidazole. Most typically a urea cure accelerator is used.

In some embodiments, the composition additionally comprises 0.5-25 wt% flame retardant additives. In some embodiments, the composition additionally comprises intumescent flame retardant additives. Any suitable intumescent flame retardant additives may be used. Suitable intumescent flame retardant additives may include intumescent graphite flame retardants such as BLAHGRAPHIT 0185 (Alroko GmbH & Co., KG, Hamburg, Germany) or Ammonium polyphosphate compounds such as INTUMAX AC-2 (Broadview Technologies Inc, Newark, NJ). In some embodiments, the composition additionally comprises red phosphorus flame retardant additives. Any suitable phosphorus based flame retardant additives may be used. Suitable phosphorus flame retardant additives may include EXOLIT RP 6500, EXOLIT OP 930, EXOLIT OP 935, or EXOLIT 1230 (Clariant International, Ltd., CH-4132 Muttenz, Switzerland). In some embodiments, the composition additionally comprises both an intumescent graphite flame retardant and a red phosphorus flame retardant.

In some embodiments, the adhesive composition comprises greater than 5 wt% flame retardant additives, in some embodiments greater than 10 wt% flame retardant additives, and in some embodiments greater than 15 wt% flame retardant additives. In some embodiments, the adhesive composition comprises less than 20 wt% flame retardant additives. In some embodiments, the adhesive composition comprises greater than 5 wt% of an intumescent graphite flame retardant and greater than 5 wt% of a red phosphorus flame retardant. In some embodiments, the adhesive composition

comprises greater than 5 wt% of an intumescent graphite flame retardant and greater than 7 wt% of a red phosphorus flame retardant. In some embodiments, the adhesive composition comprises greater than 7 wt% of an intumescent graphite flame retardant and greater than 7 wt% of a red phosphorus flame retardant. In some embodiments, the adhesive composition comprises greater than 7 wt% of an intumescent graphite flame retardant and greater than 9 wt% of a red phosphorus flame retardant.

In some embodiments, the composition additionally comprises one or more pigments. In some embodiments, the composition additionally comprises one or more toughening agents. In some embodiments, the composition additionally comprises one or more fillers. In some embodiments, the composition additionally comprises one or more rheology modifiers. In some embodiments, the composition additionally comprises one or more mineral particles. In some embodiments, the mineral particles are alumina. In some embodiments, the mineral particles are silica. In some embodiments, the mineral particles are calcite. In some embodiments, the composition additionally comprises one or more hollow microspheres. In some embodiments, the hollow microspheres are glass. In some embodiments, the hollow microspheres are polymeric. In some embodiments, the composition additionally comprises one or more fibers.

The adhesive composition according to the present disclosure may be made by any suitable method. In one method, less thermally sensitive components are first combined at elevated temperatures, such as the liquid epoxy resin, the thermoplastic resin, toughening agents, fillers, pigments, and flame retardant additives. The temperature is then reduced and more thermally sensitive components are added, such as curing agents, accelerators, and blowing agents. In some embodiments, the composition is then formed into a film.

The present disclosure also provides cured compositions resulting from cure of each of the curable compositions presented herein. In some embodiments, the cured compositions are thermocured. In some embodiments, the cured compositions are thermocured and thermoexpanded. In some embodiments, expansion upon cure (as measured according to AECMA Standard EN 2667-3) is greater than 150%, in some embodiments greater than 200%, in some embodiments greater than 250%, and in some embodiments greater than 300%.

In some embodiments the cured composition according to the present disclosure is fire retardant. In some embodiments the cured composition according to the present disclosure is fire retardant to the extent that it passes Federal Aviation Regulation (FAR) test method 25.856.

Objects and advantages of this disclosure are further illustrated by the following examples, but the particular materials and amounts thereof recited in these examples, as well as other conditions and details, should not be construed to unduly limit this disclosure.

Examples

The following abbreviations are used to describe the examples:

°C:	degrees Centigrade
°C/min:	degrees Centigrade per minute
°F:	degrees Fahrenheit
°F/min:	degrees Fahrenheit per minute
cm:	centimeter
g/cm^3	grams per cubic centimeter
mg:	milligram
mil:	10^{-3} inch
mm:	millimeter
MPa:	megaPascals

Unless stated otherwise, all other reagents were obtained, or are available from fine chemical vendors such as Sigma-Aldrich Company, St. Louis, Missouri, or may be synthesized by known methods. Unless otherwise reported, all ratios are by weight.

Abbreviations for reagents used in the examples are as follows:

BG-185:	An intumescent graphite flame retardant, obtained under the trade designation "BLAHGRAPHIT 0185" from Alroko GmbH & Co., KG, Hamburg, Germany.
CG-1200:	A micronized grade of dicyandiamide curing agent, obtained under the trade designation "AMICURE CG 1200" from Air Products & Chemicals, Inc., Allentown, Pennsylvania.
DEN-438:	An epoxy novolac resin, obtained under the trade designation "D.E.N. 438" from Dow Chemical Company, Midland, Michigan.
E-2020P:	A polyethersulphone resin, obtained under the trade designation "ULTRASON E 2020 P" from BASF Corp., Ludwigshafen am Rhein, Germany.

E-757:	1,4-Cyclohexandimethanoldiglycidylether, obtained under the trade designation "EPODIL 757" from Air Products and Chemicals Inc. A reactive diluent.
EPON-828:	A bisphenol-A polyepoxide resin having an approximate epoxy equivalent weight of 188 grams/equivalent, available under the trade designation "EPON 828", from Momentive Specialty Chemicals, Columbus, Ohio. A neat room-temperature liquid epoxy resin.
F-48D:	A thermoexpandable microcapsule produced by encapsulating volatile hydrocarbon with acrylic copolymer, obtained under the trade designation "MICROPEARL F48D" from Lehmann & Voss & Co. KG, Hamburg, Germany.
KBA:	A blue pigment, obtained under the trade designation "KEYPLAST BLUE A" from Keystone Aniline Corporation, Chicago, Illinois.
M-120:	A carbon black pigment, obtained under the trade designation "MONARCH 120" from Cabot Corporation, Boston, Massachusetts.
M-521:	A methylmethacrylate/butadiene/styrene copolymer, obtained under the trade designation "KANE ACE M521" from Kaneka America Holdings, Inc., Pasadena, Texas.
P-2650A:	A core-shell toughening agent based on butadiene rubber, obtained under the trade designation "PARALOID EXL 2650A" from Dow Chemical Company.
PKHP-200:	A micronized phenoxy resin, obtained under the trade designation "INCHEMREZ PKHP-200" from InChem Corporation, Rock Hill, South Carolina.
R-202:	A surface modified fumed silica, obtained under the trade designation "AEROSIL R202" from Evonik Industries, AG, Essen, Germany.
R-816:	A surface modified fumed silica, obtained under the trade designation "AEROSIL R 816" from Evonik Industries, AG.

RP-6500:	A blend of stabilized, micro encapsulated red phosphorus in an epoxy resin carrier, obtained under the trade designation "EXOLIT RP 6500" from Clariant International, Ltd., CH-4132 Muttenz, Switzerland.
U-52M:	A micronized grade of an aromatic substituted urea, obtained under the trade designation "OMICURE U52M" from CVC Thermoset Specialties, Moorestown, New Jersey.
Z-6040:	Glycidoxypropyltrimethoxysilane, obtained under the trade designation "Z-6040" from Dow Corning Corporation, Midland, Michigan.

Example 1

The first step is combining at elevated temperature (130°C): liquid epoxy resins, thermoplastic resin, toughening agents. In Example 1, 49.0 grams Epon 828, 23.6 grams PKHP-200 and 12.5 grams P2650A were combined in a mixing cup, type "MAX 100", obtained from Flacktek, Inc., Landrum, South Carolina. The cup was heated to 120°C in an oven, then homogeneously dispersed at 3,000 rpm for 2 minutes using a model "DAC 150 FVZ SPEEDMIXER" obtained from Hauschild Engineering & Co., KG, Hamm, Germany. The mixture was then transferred to an oven at 130°C and held for one hour, after which it was returned to the mixer, 2.0 grams of Z-6040 were added and mixed at 3,000 rpm for 2 minutes until homogeneous.

The second step is addition of inorganic fillers. In Example 1, 1.0 grams R-816 were then added and mixing continued for another 2 minutes until fully dispersed.

The third step is addition of curing agents, accelerators, and blowing agents at a reduced temperature, no more than 70°C. In Example 1, the mixture was then cooled to between 60 – 70°C, and 2.6 grams CG1200, 1.3 grams U52M, 7.8 grams F48D and 0.2 grams M-120 were added sequentially in 2 minute intervals and mixed until homogeneous.

The fourth step is film formation. In Example 1, the mixture was then manually formed into a 1.2 mm film by means of a knife coater between two polyester release liners and cooled to 21°C.

Examples 2 – 5.

The procedure generally described in Example 1 was repeated, wherein the compositions were modified according to weight percentages listed in Table 1.

Where DEN-438 and E-757 are a part of the composition, i.e., in Examples 3-5, these two components were mixed together (using a pneumatic mixer in a pail) to create a room temperature liquid epoxy prior to their use.

TABLE 1

Component	Weight %				
	Example 1	Example 2	Example 3	Example 4	Example 5
BG-185	0	0	0	0	7.4
CG-1200	2.6	2.6	4.4	4.0	3.9
DEN-438	0	0	30.7	28.2	28.5
E-2020P	0	10.0	0	0	0
E-757	0	0	4.4	4.0	4.1
EPON-828	49.0	49.0	30.7	28.2	19.2
F-48D	7.8	7.8	2.0	2.2	1.8
M-120	0.2	0.2	0	0	0
M-521	0	0	0	10.0	0
P-2650A	12.5	26.1	0	0	0
KBA	0	0	0.02	0.02	0.1
PKHP-200	23.6	0	22.0	20.1	20.3
R-202	0	0	3.9	1.5	3.7
R-816	1.0	1.0	0	0	0
RP-6500	0	0	0	0	9.2
U-52M	1.3	1.3	1.88	1.78	1.8
Z-6040	2.0	2.0	0	0	0

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Evaluations

The above examples were evaluated as follows, against a Comparative material obtained under the trade designation "SCOTCH-WELD STRUCTURAL CORE SPLICE ADHESIVE FILM AF-3024" from 3M Company. Results are listed in Table 2. This film includes solid and liquid epoxy, epoxy curative, nitrile rubber, chemical foaming agent (resulting on open cell structure) and no thermoplastic resin.

Tube Shear Strength

Samples were measured for Tube Shear Strength according to AECMA (Association of European Aircraft and Component Manufacturers) Standard EN 2667-2. The cure cycle heating rate was 3°C/min, from 70°F (21.1°C) to 250°F (121.1°C), with a temperature hold of 90 minutes at 250°F (121.1°C). Results are reported in MPa.

Expansion Ratio

Samples were measured for expansion range according to AECMA Standard EN 2667-3. The cure temperatures was 250°F (121.1°C) for 60 minutes, at a rate of 5°F/min (2.8°C/min). Results are reported as a percentage change over the original thickness.

Sag

An 8 by 8 inch by 20 mil (20.32 by 20.32 cm by 0.51 mm) 2024 aluminum panel was scored 6 inches (15.24 cm) across the panel. The panel was cleaned with isopropyl alcohol, dried, and a 1 by 2 inch (2.54 by 5.08 cm) test sample, orientated with the 2 inch (5.08 cm) length aligned with the scored line, laminated to the panel. The panel was then placed vertically in an oven, and the temperature increased to 250°F (121.1°C) at to 250F at a rate of 5°F/min (2.8°C/min), held for 60 min, then removed from the oven. After the sample cooled to 70°F (21.1°C), the distance the material flowed beyond the score line was measured.

Shelf Life

Samples were removed from storage at 0°F (-17.8°C), held at 70°F (21.1°C), and expansion ratio tests performed on a regular basis. The length of time before a noticeable change in the expansion ratio became evident was recorded.

Vertical Flame Test

Example 5, formulated to meet fire retardant requirements, passed Federal Aviation Regulation (FAR) test method 25.856.

TABLE 2

Test		Comparative	Example 1	Example 2	Example 3	Example 4	Example 5
Expansion Ratio (%)		230	230	200	190	190	317
Sag (mm)		1.5	2.0	1.5	1.0	< 1.0	< 1.0
Tube Shear (MPa)	@ -55°C	13.35	14.55	2.54	5.03	9.49	6.61
	@ 23°C	14.40	12.72	2.79	7.74	8.54	7.30
	@ 80°C	10.22	7.36	2.74	5.88	7.36	5.72
Foam Structure		Open Cell	Closed Cell	Closed Cell	Closed Cell	Closed Cell	Closed Cell
Shelf Life		≤ 10 days	3 Months	3 Months	3 Months	3 Months	3 Months

Various modifications and alterations of this disclosure will become apparent to those skilled in the art without departing from the scope and principles of this disclosure, and it should be understood that this disclosure is not to be unduly limited to the illustrative embodiments set forth hereinabove.

We claim:

1. A curable composition comprising:
   a) 30-80 wt% of a room temperature liquid epoxy resin;
   b) 0.5-10 wt% of an epoxy curative;
   c) 5-40 wt% of a thermoplastic resin; and
   d) 0.5-10 wt% of a physical blowing agent.

2. The curable composition according to any of the preceding claims containing no epoxy resin other than room temperature liquid epoxy resin.

3. The curable composition according to any of the preceding claims containing an epoxy/reactive diluent room temperature liquid epoxy resin.

4. The curable composition according to any of the preceding claims containing a mixture of a neat room temperature liquid epoxy resin and an epoxy/reactive diluent room temperature liquid epoxy resin.

5. The curable composition according to any of the preceding claims containing 40-60 wt% of the room temperature liquid epoxy resin.

6. The curable composition according to any of the preceding claims wherein the thermoplastic resin has a softening point of between 60 °C and 150 °C, as measured by DIN EN ISO 306 method A50.

7. The curable composition according to any of the preceding claims wherein the thermoplastic resin is a polymer comprising phenylene oxide (-Ph-O-) units in its polymer backbone.

8. The curable composition according to any of the preceding claims wherein the thermoplastic resin is a copolymer of bisphenol a and epichlorhydrin.

9. The curable composition according to any of the preceding claims wherein the thermoplastic resin is a polyethersulfone.

10. The curable composition according to any of the preceding claims containing 16-25 wt% of the thermoplastic resin.

11. The curable composition according to any of the preceding claims additionally comprising 10-20 wt% flame retardants.

12. The curable composition according to any of the preceding claims additionally comprising greater than 5 wt% of an intumescent graphite flame retardant and greater than 7 wt% of a red phosphorus flame retardant.

13. The curable composition according to any of the preceding claims which demonstrates expansion upon cure of greater than 250%.

14. The curable composition according to any of the preceding claims which cures to a composition that is fire retardant.

15. The curable composition according to any of the preceding claims containing no blowing agent other than a physical blowing agent.

16. A film of the curable composition of any of the preceding claims.

17. The film according to claim 16 which has a thickness of less than 2 mm.

18. A cured composition obtained by curing the curable composition of any of claims 1-15.

19. The composition of claim 18 that is fire retardant.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/044857

A. CLASSIFICATION OF SUBJECT MATTER
INV. C08J5/18 C08J9/12 C09K21/00 C08L63/00
ADD.

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)
C08J C09K C08L

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 700 683 A1 (3M INNOVATIVE PROPERTIES CO [US]) 26 February 2014 (2014-02-26) page 4, paragraph 19 page 6, lines 55,56, paragraph 40 claims 2,7	1-19
X	WO 2007/025036 A1 (DOW GLOBAL TECHNOLOGIES INC [US]; GOLDEN MICHAEL R [US]) 1 March 2007 (2007-03-01) page 3, line 18 - line 29 page 4, lines 1,2 page 4, lines 4,33 page 5, line 25 claim 1	1-19

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

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
14 October 2015	22/10/2015

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2015/044857

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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