

INTUMESCENT COMPOSITION

This invention relates to intumescent materials which find application as fire-stop materials, for example fire penetration seals and cavity fire-stops, and otherwise.

5 Known intumescent fire-stop or penetration-sealing products include: sealants and mastics which comprise exfoliating graphite in a suitable carrier material; intumescent pipe bands, collars and wraps; intumescent blocks, grills and strips; intumescent fire pillows; intumescent
10 expansion joints; intumescent cavity and lap-jointing seals; intumescent paints; lightweight cavity barriers; and doorstrips which comprise intumescent material. All the intumescent products mentioned may contain exfoliating graphite.

15 These products are incorporated into buildings at various stages and places in their construction and all have the property of intumescenting when subjected to the heat of a fire and thereby closing a passageway through which the fire, flame and/or smoke would otherwise spread. The products thereby
20 protect the elements of the building from structural collapse.

The products are however subject to disadvantages in that their incorporation into or onto the structure of a building is a time-consuming operation or, in certain cases, the products themselves (e.g. cavity seals, lap joints,
25 lightweight cavity barriers and doorstrips) are difficult to manufacture as they consist of assemblies of two or more component parts.

According to the present invention a material comprising one or more of polyvinyl chloride, polyethylene,
30 polypropylene, polyethylene-polypropylene copolymers, acrylic polymers and copolymers, metallocene polymers, silicone

rubbers and polymers and natural and synthetic polymer and rubber latexes (preferably comprising one or more of the foregoing) is used as a carrier for exfoliating graphite in an intumescent composition.

5 The invention also provides an intumescent composition which comprises the said carrier material and exfoliating graphite.

Intumescent compositions according to the invention can be produced by extrusion of a mixture of the said carrier
10 material and exfoliating graphite, the extrusion process preferably being a melt-extrusion process. The invention accordingly provides an extrudable mixture comprising the said carrier material and exfoliating graphite and a composition produced by extrusion, preferably melt-extrusion, of a mixture
15 of the said carrier material and exfoliating graphite.

Preferably when the carrier material comprises one or more acrylic polymer or copolymer and/or one or more silicone rubber or polymer, the intumescent composition according to the invention can be produced by mixing of the carrier
20 material (preferably in the form of a latex) with the exfoliating graphite. The invention accordingly provides such a mixture.

The amount of carrier material in the composition or extrudable mixture is preferably from 30 to 45% by weight of
25 the composition or mixture.

In all aspects of the invention, the amount of exfoliating graphite is preferably from 5 to 50 % by weight, more preferably 15 to 45% by weight, most preferably 25 to 35% by weight of the composition or mixture.

30 Compositions and extrudable mixtures of the invention preferably contain one or more plasticisers, at least one of

which preferably has a fire-retardant effect.

The or at least one of the plasticisers is preferably a phthalate plasticiser.

The plasticiser(s) are suitably present in an amount of 5 up to 35% by weight of the composition or mixture, preferably from 10 to 30% by weight, more preferably 20 to 30% by weight.

The compositions and extrudable mixtures of the invention preferably also contain one or more stabilisers, preferably of low toxicity, suitably in a total amount of up 0.05% by 10 weight of the composition or mixture, preferably 0.015 to 0.025% by weight.

Compositions and extrudable mixtures of the invention may contain an inert filler, preferably in an amount of 4 to 6% by weight of the composition or mixture.

15 Suitable exfoliating graphite materials are those sold under the names "Callotek 50", "Callotek 100", "Callotek 200", "Callotek 500" and "Callotek 600" and available from P.F.C. Surechem Limited of Davis Road, Chessington, Surrey, KT9 1TV, United Kingdom.

20 In another aspect, the present invention provides a composite product comprising a co-extrusion of first and second materials, the first material being an intumescent composition comprising exfoliating graphite in a carrier material.

25 Preferably, the carrier material is polyvinyl chloride, polyethylene, polypropylene or a polyethylene-polypropylene copolymer, the first material preferably containing from 5 to 50% by weight of exfoliating graphite, more preferably 15 to 45% by weight, most preferably 25 to 35% by weight, based on 30 the weight of the first material.

The amount of carrier material in the first material is

preferably from 30 to 45% by weight of the first material.

The first material may contain one or more plasticisers and/or one or more stabilisers and/or an inert filler, of the types and in amounts based on the first material as stated 5 above for the first-mentioned composition of the invention.

The second material preferably comprises one or more of polyvinyl chloride, polyethylene, polypropylene and a polyethylene-polypropylene copolymer.

Advantageously, the second material and the carrier 10 material are chosen for compatibility with each other, particularly upon co-extrusion, and are preferably the same material, more preferably polyvinyl chloride.

The composite product of the invention may take the form of a tube of multi-layer wall construction, the outer or inner 15 layer of the tube wall being preferably of the first material. Another preferred product is a tube having a wall construction which comprises a layer of the second material between first and second layers of the first material.

Examples of tubes constituting composite products 20 according to the invention are pipes for gases or liquids and electrical and cable conduits. Another example is a hose in which the second material is neoprene rubber and the carrier material is polyvinyl chloride, polyethylene, polypropylene or a polyethylene-polypropylene copolymer.

25 A further product according to this aspect of the invention comprises a tube of the second material which is filled completely with the first material.

Another product according to this aspect of the invention comprises a doorstrip or a door or window frame profile, in 30 which the first material forms an intumescent element within the second element. It need not however be that the first

material is fully enclosed in the extrusion of the second material: for example, U- and C-shaped and flat extrusions of the second material are also within the scope of the invention. Articles of these types all provide fire-stop and/or flame- or smoke-retardant functions when used in building construction.

In all cases, the second material may be flexible or rigid according to its intended use, and may have its other physical properties also chosen to suit it to the intended use.

In all cases in which the tube wall construction comprises a layer (which may be an inner, outer or intermediate layer) of the first material, the tube, when passed through an opening, for example in a wall or floor, in a building construction, acts as a smoke-stop, flame-stop and/or fire-stop component without any additional wrapping or collar being fitted around it to form a fire-stop.

When the tube is subjected to heat, the intumescent material intumesces and acts to block the bore of the tube. This is particularly advantageous for tubes used to convey flammable materials, for example gas pipes and fuel lines. It is desirable for the layer containing intumescent material to form the inner layer of the pipe or tube.

In yet another aspect, the present invention provides an electrical cable of which the insulation comprises an intumescent material comprising exfoliating graphite in a carrier material. Examples of suitable cables are electrical cables generally, telecommunication cables, data transmission cables and coaxial cables.

The intumescent material preferably forms at least one tubular layer extending around at least one conductor of the

cable. The conductor may be a single strand or consist of a plurality of strands. Thus, cable structures in which the intumescent material forms a tubular layer around each individual conductor, or at least those having their own
5 insulating layers, and structures in which the intumescent material forms a tubular layer around all the conductors and within the sheathing layer of the cable, are within the scope of the invention. Further, the invention also provides a cable in which a layer of intumescent material forms an outer
10 tubular layer enclosing the sheathing layer of the cable.

The carrier material preferably comprises one or more of polyvinyl chloride, polyethylene, polypropylene, a polyethylene-polypropylene copolymer, an acrylic polymer or copolymer and a metallocene polymer; the insulation and
15 sheathing layers of the cable are also preferably of one of these materials.

The amounts of carrier material and exfoliating graphite are preferably as stated above, for the carrier material and exfoliating graphite of the first-mentioned composition
20 according to the invention.

The intumescent material may contain one or more plasticisers and/or one or more stabilisers and/or an inert filler of the types and in the amounts based on the carrier material stated above for the first-mentioned composition
25 according to the invention.

In each cable according to the invention, the intumescent material swells to enlarge the cable and perform a fire-stop, anti-smoke-spread and/or anti-flame-spread function when the cable is subjected to the heat of a fire. When the cable is
30 installed in a conduit or otherwise passes through a confined space within a building, for example through a fire wall or

floor, this intumescence provides a fire-stop, anti-smoke-spread and/or anti-flame-spread, effect.

The terms "polyvinyl chloride" and "PVC" are each used throughout this specification and its claims to cover plasticised and unplasticised polyvinyl chloride and also derivatives of both those materials. Similarly the terms "polyethylene", "polypropylene" and "polyethylene-polypropylene copolymer" are used to cover both these materials themselves and also derivatives thereof.

The invention will be described further by way of the following examples 1 to 3.

Compositions according to the invention were produced by introducing the following ingredients into the feed hopper of an extruder filled with a suitable extrusion die:

ingredient	amount (g)		
	example 1	example 2	example 3
PVC granules	380	-	-
PVC powder	-	100	100
PVC-compatible stabiliser/lubricant	0.2	-	-
dioctyl phthalate plasticiser	150	52	-
acrylonitrile-butadiene-styrene impact modifier	-	-	8
acrylic process aid	-	-	1.5
epoxidised soya bean oil	-	5	1.5
barium-zinc stabiliser	-	2	-

15	ingredient	amount (g)		
		example 1	example 2	example 3
	tin stabiliser	-	-	2.5
	fatty acid ester glycerine lubricant	-	-	1.2
	paraffin wax	-	-	0.4
5	chlorinated paraffin (fire retardant plasticiser)	110	30	-
	Callotek 500 exfoliating graphite	310	85	50
10	PVC-compatible inert filler	49.8	-	7
	TOTAL	1000	274	172.1

Embodiments of the invention will now be described by way
 15 of example with reference to the drawing, in which:

Figure 1 is a transverse sectional view of an electrical
 conduit having a twin-walled construction;

Figure 2 is a transverse sectional view of an electrical
 conduit having a triple-walled construction;

20 Figure 3 is a transverse sectional view of a fuel pipe
 having a twin-walled construction;

Figure 4 is a transverse sectional view of a filled
 profile member according to the invention;

Figure 5 is a transverse sectional view of a first
 25 electrical cable;

Figure 6 is a transverse sectional view of a second
 electrical cable;

Figure 7 is a transverse sectional view of a third

electrical cable; and

Figure 8 is a transverse sectional view of a coupling which can act as a fire and smoke seal where electrical cables pass through a wall or similar part of a building.

5 Figure 1 of the drawings shows an electrical conduit having an outer layer 10 of rigid PVC material as in a conventional electrical conduit and an inner layer 12 of a composition made in accordance with any of examples 1 to 3. The conduit is produced by co-extrusion through an extruder
10 fitted with a suitable extrusion die of PVC granules to form the outer layer 10 and a blend of the ingredients listed in example 1 to form the inner layer 12.

An electrical conduit as shown in figure 1 and having an inner layer of a composition in accordance with example 1 was
15 tested for compliance with British Standard 476, Part 20 (see British Standards Institution document UDC 614.841.332: 620.1: 69.01: 6909.81) for fire penetration. The conduit had an outside diameter of 20 mm. The inner layer was 2 mm thick. The test involved placing the conduit between opposed panels
20 of mineral fibre slab each 50 mm thick and coated with a 1 mm ablative coating. Heat transfer through the sample from a furnace at 1200°C heating one of the panels was measured. The sample produced an integrity rating of 186 mins, with an insulation rating of 75 mins.

25 Figure 2 shows a conduit having an intermediate layer 20 of the same material as the outer layer 10 of the conduit of figure 1 and inner and outer layers 22, 24 of a composition made in accordance with any of examples 1 to 3 herein. The conduit is produced by co-extrusion as above using a suitable
30 extrusion die.

The fuel pipe shown in Figure 3 comprises an outer layer

30 of latex rubber and an inner layer 32 of a composition made in accordance with any of examples 1 to 3 herein. The fuel pipe is made by co-extrusion of the rubber and the ingredients listed in the example using a suitable extrusion die.

5 Figure 4 of the drawings shows a filled, profiled element produced by co-extrusion of PVC and the ingredients of any of examples 1, 2 and 3 using a suitable extrusion die. The outer part 40 of the extrusion is of circular cross-section and is filled completely with the composition of the respective
10 example. In other embodiments, the outer part can be of any desired cross-section, for example that of a door, window or cladding component, or a door or window frame. Another example is a rectangular-section which forms a doorstrip for insertion into the frame of a fire door. In all cases, the
15 filled profiled element intumesces to produce a fire-stop effect when subjected to the heat of a fire.

The electrical cable of Figure 5 comprises insulated line and neutral conductors 50,52 and an uninsulated earth conductor 54. The three conductors 50,52,54 are encased in
20 a sheathing 56 of PVC which is itself covered by a layer 58 of a composition made in accordance with any of examples 1, 2 and 3. The cable is produced by co-extrusion of PVC and the ingredients listed in the respective example, through a suitable extrusion die through which the conductors 50,52,54
25 are also fed.

The cable of Figure 6 comprises conductors 60,62,64 which correspond to the conductors 50,52,54 of the cable of Figure 5. Each of the insulated conductors 60,62 has around it a respective layer 66,68 of a composition made in accordance
30 with example 1, 2 or 3, around which a sheathing 70 of PVC is formed. The cable is produced by co-extrusion of PVC and the

ingredients listed in the respective example, through a suitable extrusion die through which the conductors 60, 62, 64 are also fed.

Figure 7 shows a cable which comprises insulated line and 5 neutral conductors 72, 76 and an uninsulated earth conductor 74. The three conductors 72, 74, 76 are encased in sheathing 71 made from a composition in accordance with any of examples 1, 2 and 3. The sheathing 71 is covered by an outer layer 80 of PVC. The cable is produced by co-extrusion of the 10 composition according to the invention and PVC through a suitable extrusion die through which the conductors 72, 74 and 76 are also fed.

An electrical cable as shown in figure 7 having a sheathing 71 of a composition in accordance with example 2 was 15 tested for compliance with British Standard 476, Part 20 (see British Standards 476, Part 20 (see British Standards Institution document UDC 614.841.332: 620.1: 69.01: 6909.81) for fire penetration as described above. The sample produced an integrity rating of 210 min, with an insulation rating of 20 45 min.

An electrical cable as shown in figure 7 having a sheathing of a composition in accordance with example 1 was tested for compliance with International Electrical Committee tests 61034, 60754-1 and 60754-2.

25 Test 61034, relating to measurement of smoke density of electrical cables burning under defined conditions, produced a test rating of 62%, compared with a minimum test requirement of 50%.

Test 60754-1, relating to the amount of halogen gases 30 evolved during combustion of cable materials, produced a test rating of 16, compared with a maximum test requirement of 100.

Test 60754-2, relating to the acidity of gases evolved and the conductivity of the cable during combustion of the cable, produced a test rating OF 4.6%, compared with a minimum test requirement of 4.3%.

5 The coupling 82 shown in Figure 8 is made from a composition in accordance with any of examples 1, 2 and 3. The coupling is extruded in sections of suitable length to allow coupling of conduits or pipes which are not rated for fire resistance where they pass through fire-rated walls or
10 floors. A fire, flame and/or smoke seal is therefore produced and is effective when subjected to the heat of a fire.

CLAIMS:

1. An intumescent composition comprising exfoliating graphite and a carrier material selected from polyvinyl chloride, polyethylene, polypropylene, polyethylene-
5 polypropylene copolymers, acrylic polymers and copolymers, metallocene polymers, silicone rubbers and polymers and natural and synthetic polymer and rubber latexes and mixtures of any of the foregoing.
2. An extrudable mixture comprising exfoliating
10 graphite and a carrier material selected from polyvinyl chloride, polyethylene, polypropylene, polyethylene-polypropylene copolymers, acrylic polymers and copolymers, metallocene polymers, silicone rubbers and polymers and natural and synthetic polymer and rubber latexes and mixtures
15 of any of the foregoing.
3. An intumescent composition produced by extrusion of an extrudable mixture according to claim 2.
4. An intumescent composition according to claim 3 produced by melt-extrusion.
- 20 5. A composition or mixture according to any preceding claim, in which the amount of carrier material is from 30 to 45% by weight of the composition or mixture.
6. A composition or mixture according to any preceding claim, in which the amount of exfoliating graphite is from 5
25 to 50% by weight of the composition or mixture.
7. A composition or mixture according to claim 6, in which the amount of exfoliating graphite is from 15 to 45 % by weight of the composition or mixture.
8. A composition or mixture according to claim 7, in
30 which the amount of exfoliating graphite is from 25 to 35% by weight of the composition or mixture.



9. A composition or mixture according to any preceding claim, containing at least one plasticiser, the total amount of plasticiser(s) being no more than 35% by weight of the composition or mixture.

5 10. A composition or mixture according to claim 9, in which the total amount of plasticiser(s) is from 10 to 30% by weight of the composition or mixture.

11. A composition or mixture according to any preceding claim, containing at least one stabiliser, the total amount
10 of stabiliser(s) being no more the 0.05% by weight of the composition or mixture.

12. A composition or mixture according to claim 11, in which the total amount of stabiliser(s) is from 0.015 to 0.025% by weight of the composition or mixture.

15 13. A composition or mixture according to any preceding claim, containing at least one inert filler, the total amount of filler(s) being from 4 to 6% by weight of the composition or mixture.

14. A composite product comprising a co-extrusion of
20 first and second materials, the first material being an intumescent composition comprising exfoliating graphite and a carrier material which is preferably selected from polyvinyl chloride, polyethylene, polypropylene, polyethylene-polypropylene copolymers, acrylic polymers and copolymers,
25 metallocene polymers, silicone rubbers and polymers and natural and synthetic polymer and rubber latexes and mixtures of any of the foregoing.

15. A composite product according to claim 14, in which the amount of carrier material is from 30 to 45% by weight of
30 the intumescent composition.

16. A composite product according to claim 15, in which



the amount of exfoliating graphite is from 5 to 50% by weight of the intumescent composition.

17. A composite product according to claim 16, in which the amount of exfoliating graphite is from 15 to 45 % by weight of the intumescent composition.

18. A composite product according to claim 17, in which the amount of exfoliating graphite is from 25 to 35% by weight of the intumescent composition.

19. A composite product according to any of claims 14 to 18, containing at least one plasticiser, the total amount of plasticiser(s) being no more than 35% by weight of the intumescent composition.

20. A composite product according to claim 19, in which the total amount of plasticiser(s) is from 10 to 30% by weight of the intumescent composition.

21. A composite product according to any of claims 14 to 20, containing at least one stabiliser, the total amount of stabiliser(s) being no more than 0.05% by weight of the intumescent composition.

22. A composite product according to claim 21, in which the total amount of stabiliser(s) is from 0.015 to 0.025% by weight of the intumescent composition.

23. A composite product according to any of claims 14 to 22, containing at least one inert filler, the total amount of filler(s) being from 4 to 6% by weight of the intumescent composition.

24. A composite product according to any of claims 14 to 23, in which the second material comprises one or more of polyvinyl chloride, polyethylene, polypropylene, polyethylene-polypropylene copolymers and mixtures thereof.

25. A composite product according to any of claims 14



to 24, the product being in the form of a tube having a multi-layer wall construction, the layers comprising at least one of the first material and at least one of the second material.

26. A composite product according to claim 25, in which
5 the innermost layer is of the first material.

27. A composite product according to claim 25, in which the outermost layer is of the first material.

28. A composite product according to claim 25, in which the wall construction comprises a layer of the second material
10 directly between respective layers of the first material.

29. A composite product according to any of claims 14 to 24, the product being in the form of a continuous profile the cross-section of which has respective portions comprising the first and the second materials.

15 30. A composite product according to claim 29, in which the portion of the first material provides a part of the outer surface of the product.

31. A composite product according to claim 30, in which the portion of the second material is of C-shaped cross-
20 section.

32. A composite product according to claim 30, in which the portion of the second material is of U-shaped cross-section.

33. A composite product according to claim 29, in which
25 the portion of the first material provides a central core of the product.

34. A composite product according to claim 33, in which the portion of the second material provides a tubular sleeve directly around the central core.

30 35. A composite product according to any of claims 14 to 24 in the form of an electrical cable having at least one



continuous conductor, at least one continuous cross-sectional portion of the cable comprising the first material.

36. An electrical cable according to claim 35, in which the portion of the first material extends around the or all
5 the conductors of the cable.

37. An electrical cable according to claim 35, in which the cable has a plurality of conductors, around at least one of which a respective portion of the first material extends.

38. An electrical cable according to claim 36, in which
10 the said portion of the first material provides the outer surface of the cable.

39. An electrical cable according to claim 36, in which the said portion of the first material provides a continuous inner core of the cable through which the or each conductor
15 extends and the second material provides a continuous outer surface of the cable.

40. A method of co-extruding an electrical cable according to any of claims 35 to 39, in which the conductor(s) of the electrical cable are fed through an extrusion die used
20 to co-extrude the first and second materials.

41. A tubular article formed from an intumescent composition according to any of claims 1, 2 and 4.

42. An intumescent composition substantially as hereinbefore described with reference to any of examples 1 to
25 3 hereof.

43. A composite product substantially as hereinbefore described with reference to any of figures 1 to 8 of the drawings.

44. An electrical cable substantially as hereinbefore
30 described with reference to any of figures 5 to 7 of the drawings.



45. A coupling piece substantially as hereinbefore described with reference to figure 8 of the drawings.

