Abstract Title: POLYMER COATED WIRE OR CABLE

A wire or cable comprises a core 10 and a sheath including a wrapped film 15,16 of polyetherether ketone (PEEK) or a polymer blend or alloy thereof having a thickness less than 150 micrometers. Preferably included is a flame proofing layer 14 comprising mica particles dispersed in a polymer matrix such as a silicone. An outer coating 18 of PEEK or another polymer may be provided, which may be sintered to provide a tough outer protective covering. The PEEK and mica layers combine synergistically to provide a sheath of increased flame resistance as well as high flexibility and resistance to mechanical stresses, while being of reduced weight and diameter. The core may be a polymeric, carbon fiber, ceramic core or a metallic core such as copper, aluminium, silver or steel.
HIGH PERFORMANCE, HIGH TEMPERATURE WIRE OR CABLE

This invention relates to high performance, high temperature and preferably fire resistant wires and cables for use in demanding or extreme conditions such as in drilling or mining, commercial or military aerospace and marine applications and automotive, rail and mass transport. Such cables may be exposed to extremes of temperature as well as to corrosive substances or atmospheres or to fire. High performance wires generally comprise a functional core such as an electrical conductor or optical fibre, and one or more insulating and/or protective coatings. These coatings should be flexible and not too bulky, since wires are required in many cases to be of small diameter.

Various types of polymer are known for use in wire and cable sheaths, such as polytetrafluoroethylene (PTFE) and polyetheretherketone (PEEK). PTFE has the advantage of being very tough as well as chemically inert, with a high softening point, low coefficient of friction and good electrical insulating properties.

PEEK has found increasing use in wire and cable sheathing since it has good flame resistance, being self-extinguishing with very low smoke. It also has good elongation, good flexibility in thin sections such as films and good mechanical resistance to dynamic cut-through and scrape abrasion. It can however be susceptible to arc tracking and also to attack by acetone and strong acids.
EP-A-572 177 discloses an electrical insulation laminate of porous PTFE and PEEK. The purpose of this is to provide a flexible electrical insulation material for air frame wire insulation which is lightweight with high mechanical strength, thermal resistance and chemical resistance and reduced dielectric constant.

There remains however a demand for wire and cable insulations that are resistant to fire as well as to very high temperatures. One way of imparting such flame resistance is to apply a coating comprising mica particles, typically platelets, dispersed in a polymer matrix. JP-A-2003100149 for example discloses the use of a dispersion of fine mica powder and glass frit in a silicone resin for coating fire resistant cables. Mica can however add to the cost and accordingly there is a need to reduce the mica content of cable sheaths. For example, JP-A-2006120456 seeks to avoid the use of mica by combining a glass tape to impart tensile strength and dimensional stability with a silicone tape to impart heat resistance, electrical characteristics and adhesiveness.

JP-A-2000011772 discloses a fire resistant coating made with a cross-linked silicone rubber mixed with aluminium hydroxide and mica powder.

There is also a requirement for wires and cables of reduced diameter, which could be achieved by using sheaths of reduced thickness.
According to the present invention, a high performance, high temperature wire comprises a core and a sheath including a wrapped film made from polyetheretherketone (PEEK), or a blend or alloy of PEEK with another polymer, the blend or alloy containing at least 30% by weight of PEEK, preferably at least 50% and more preferably at least 80%. The wrapped film may include other polymeric components, and may be combined with other polymeric layers and in particular with flameproofing or fire-resistant layers.

In particular embodiments of the invention, the PEEK tape is combined with a fire-resistant layer or for example one comprising mica dispersed in a polymeric matrix such as a silicone, a silica-based polymeric matrix or a polymeric siloxane. This fire-resistant layer may be in the form of a separate layer radially inside or outside the PEEK layer. Alternatively it may be combined with a film formed from a PEEK tape.

The fire-resistant layer may have a backing layer, for example a supporting layer of glass fibre or a layer of another polymer such as a polyolefin.

In another embodiment the PEEK film may comprise two layers of PEEK with a layer of mica between them. The mica layer may comprise a sheet or foil or a layer of particles. It may suitably have a thickness of 30 to 200μm, preferably not more than 100μm.
An additional outer layer may be provided for additional strength, flexibility and/or flame resistance. This outer layer may for example comprise polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVDF), ethylenetetrafluoroethylene (ETFE), PEEK, polyolefins, polyamides, siloxanepolyetherimide (SILTONE), thermoplastic polyetherimides such as Ultem, polyesters, silicones, polyurethanes, epoxy resins, acrylic resins or copolymers or blends or alloys of any these. This outer layer may be sintered.

It has been found that the PEEK film and mica-containing film can combine synergistically to provide a wire or cable sheath of increased flame resistance as well as resistance to mechanical stresses such as bending, stretching and abrasion. This means that relatively thin films can be used to produce wires of reduced overall diameter. The PEEK tapes used according to the present invention are preferably of a thickness of from 10-100 μm.

The coatings described above can be applied to numerous different types of core, notably conductive wires or cables, for example copper, which may be nickel or tin coated or silver-plated, aluminium, typically copper-clad aluminium, silver or steel. For other purposes, non-metallic cores such as carbon fibre or polymeric or ceramic cores may be used. The cable may be single core or multi-core or may comprise a twisted pair of wires, a multi-strand core or a braid. Any of these cores may be coated with copper, nickel, tin or silver.
Preferred embodiments of the invention will now be described with reference to the accompanying drawings wherein:

FIG.1 shows how an insulated wire according to the present invention can be made by wrapping PEEK and other polymeric tapes;

FIG.2 is a cross-section through a multi-coated wire in accordance with a first embodiment of the invention;

FIG.3 is a cross-section through a coated wire in accordance with a second embodiment of the invention;

FIG.4 is a cross-section through a third embodiment of the invention; and

FIG.5 is a cross-section through a fourth embodiment of the invention.

Referring first to Fig.1, a multi-stranded cable 10, which may for example be of copper, uncoated or coated with nickel, silver or tin, aluminium, which may be copper clad, steel or a non-metallic cable such as carbon fibre, polymer fibre or ceramic fibre has a three-layer sheath applied to it by winding and extrusion. A first tape 12, for example of silicone with mica platelets distributed in it, is wound on spirally to form a first wound coating 14. Then a second tape 15, for example of polyetheretherketone, is wound on spirally to form a second coating 16. Finally an outer layer of another polymer is applied, for example by extrusion.

Fig.2 shows a cross-section through a cable to which a three-layer sheath has been applied, for example as described in relation to Fig.1. The innermost layer 24, immediately
surrounding the cable 20, is a mica-containing sheath to impart flame resistance. This may for example be a mica-containing silicone tape which may be backed with a glass fibre and/or with a polyethylene layer. This layer may be applied in single or multiple layers of the same or different thicknesses.

The second layer 26 comprises polyetheretherketone (PEEK) wound tape having a thickness of 10 to 100 μm. The PEEK may be used alone or blended or alloyed with other polymers that preferably contain at least 60%, and more preferably at least 80%, of PEEK.

The outer layer 28 is optional according to the invention, but when used can be either extruded or wrapped. It provides an encapsulation layer to form an additional layer of protection to the cable. Any of the polymers, polymer blends or alloys listed above for this layer can be used. PTFE for example could sintered to provide exceptional chemical resistance as required by the aerospace market. The PEEK layer itself could be sintered to provide a tough outer layer in its own right.

The synergistic combination of mica-containing polymer and PEEK in this embodiment can provide a high temperature, fire resistant wire with potentially low weight and low overall diameter. The mica can provide insulation and fire resistance up to 1000°C, and in combination with the PEEK provides very good mechanical properties including dynamic cut-through resistance, even at high temperatures, non burning characteristics and very low smoke emission. The PEEK layer could be sintered or fused to provide a though outer layer in its own right.
Referring now to the embodiment of Fig.3, the core cable or wire 30 can be of similar to that of Fig.2 but the first layer 32 of the sheath is a combined wrapped layer formed from a single or double mica layer on a PEEK film or tape. The mica component may for example comprise a mica/silicone tape, with or without a polyethylene layer. This embodiment may also include an optional outer layer 34, for which the range of contents may be the same as for the embodiment of Fig.2. Again, the outer layer may be sintered.

In the embodiment of Fig.4, the core 40 is first sheathed with an inner layer 42 comprising a wrapped film of PEEK or of a blend or alloy of PEEK with another polymer. Around this is an outer layer which may be applied by wrapping or extrusion and may comprise a flameproofing layer of mica and/or alumina particles dispersed in a polymer such as silicone, or a protective layer of any of the polymers used for the outer layers of the wires or cables illustrated in Figs. 2 and 3. Again, this outer layer may be sintered to provide a tough outer layer.

As illustrated in Fig.5, a wrapped PEEK film 54, or a wrapped film of a blend or alloy of PEEK with one or more other polymers, can be used as an outer protective layer for a wide variety of wire or cable constructions. This could include a conductor with another polymeric insulation, a complete cable construction with or without a braid, such as a twisted pair or a quad of twisted pairs such as Cat 7 cable. In the embodiment illustrated in Fig.5, the PEEK outer jacket is formed around a
three-core cable 50 with a flameproofing or fire-resistant insulation layer 52 of mica particles in a matrix of silica or the like. The PEEK outer jacket may be fused or sintered.
CLAIMS

1. A wire or cable comprising a core and a polymeric sheath, wherein said sheath includes a wrapped film of polyetherether ketone (PEEK), or a polymer blend or alloy of PEEK containing at least 30% by weight of PEEK and another polymer, having a thickness of 5 to 150μm.

2. A wire or cable according to claim 1 wherein the wrapped PEEK film has a thickness of 10 to 100μm.

3. A wire or cable according to claim 1 or claim 2 wherein the wrapped PEEK film comprises a blend or alloy containing at least 50% by weight of PEEK.

4. A wire or cable according to claim 3 wherein the wrapped PEEK film comprises a blend or alloy containing at least 80% by weight of PEEK.

5. A wire or cable according to any preceding claim wherein the wrapped PEEK film comprises two layers of PEEK with a layer of mica between them.

6. A wire or cable according to any preceding claim wherein the PEEK film is combined with a layer of another polymer.

7. A wire or cable according to claim 6 wherein the layer with which the PEEK film is combined is a fire-resistant
layer of a polymer matrix in which mica particles are dispersed.

8. A wire or cable according to claim 7 wherein the matrix of the fire-resistant layer comprises silicone rubber, a silica-based polymeric matrix or a polymeric siloxane.

9. A wire or cable according to claim 7 or claim 8 wherein the fire-resistant layer is formed from a wrapped tape.

10. A wire or cable according to claim 9 wherein the wrapped tape of fire-resistant material has a supporting or backing layer.

11. A wire or cable according to claim 10 wherein the wrapped layer of fire-resistant material is a glass fibre-backed tape.

12. A wire or cable according to any one of claims 7 to 11 wherein the fire-resistant layer is formed as an inner layer around the core, with the PEEK film wrapped around it.

13. A wire or cable according to any one of claims 6 to 12 comprising a combined inner layer, around the core, of a PEEK film and a polymeric tape with mica particles dispersed therein.

14. A wire or cable according to claim 13 wherein the combined inner layer includes a polyolefin film.
15. A wire or cable according to any preceding claim further comprising an outer protective polymer layer.

16. A wire or cable according to claim 15 wherein said outer layer is formed of a polymer selected from polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVdf), ethylenetetrafluoroethylene (ETFE), PEEK, polyolefins, polyamides, siloxanepolyetherimide, thermoplastic polyetherimides, polyesters, silicones, polyurethanes, epoxy resins or acrylic resins, or blends or alloys of any of these.

17. A wire or cable according to claim 15 or claim 16 wherein the outer protective polymer layer is sintered or fused.

18. A wire or cable according to any preceding claim wherein the PEEK film is at least partly sintered or fused.

19. A wire or cable according to any preceding claim wherein the core is a polymeric, carbon fibre or ceramic core.

20. A wire or cable according to any one of claims 1 to 18 wherein the core is a conductive metallic core.

21. A wire or cable according to claim 20 wherein the core is of copper, aluminium, silver or steel.
22. A wire or cable according to any one of claims 19 to 21 wherein the core is coated with copper, nickel, tin or silver.
Application No: GB0810294.9  Examiner: Mr Tyrone Moore
Claims searched: 1-22  Date of search: 27 August 2008

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

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<td>US 5393929 A (JUNKOSHA CO LTD) See whole document.</td>
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKPC:

Worldwide search of patent documents classified in the following areas of the IPC

H01B

The following online and other databases have been used in the preparation of this search report

WPI; EPODOC.

International Classification:

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