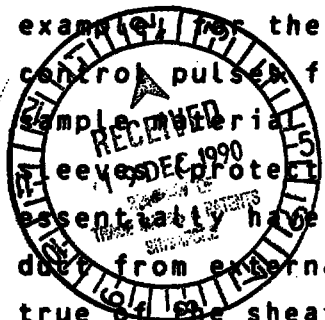


DESCRIPTIONELONGATED PRODUCTS COMPRISING A POLYMER (OR COPOLYMER)
OF ETHYLENE

The present invention relates to elongated products, such as electrical cables or tubes, made from a polymeric material which is crosslinked by grafted-on unsaturated vinyl silane compounds under the action of moisture, or made
5 from layers containing such material.

After the extrusion of, for example, a lead insulation made of grafted insulating material, the lead is subjected to the influence of moisture for the purpose of
10 crosslinking the insulation, for example by introducing the respective length of lead, coiled onto drums or reels, into a temperature-controlled sauna. The length of time for which the length of lead is present in the sauna depends essentially on the wall thickness of the insulation.
15 By suitable temperature control and specific air replacement, the crosslinking times can be considerably reduced (German Published Specification 3,003,155 and German Published Specification 3,003,156). The crosslinking can also be carried out in a hot water bath, but this leads
20 to heavy contamination of the lead surface when conventional iron drums are used. The working stage of crosslinking thus still means an additional complication, both technically and also regarding time.

External coverings, for example the sheaths of
25 electrical cables or tube bundle cables which are used, for example, for the pneumatic relaying of the measurements or control pulses from plants and also for the removal of sample material in the chemical industry, or the external
sleeves (protective pipes) of media-carrying pipe-lines,
30 essentially have the task of protecting the sheath product from external mechanical influences. The same is true of the sheaths of so-called channel pipe-type cables,



but also for the individual pipes which are assembled together in such systems and which lie parallel next to one another or are arranged in a bundle, which are used, for example, for accommodation of communications cables having optical fibres which are laid in the ground.

As a rule, hard or soft polyethylene is used as material for these sheaths, sleeves or protective pipes, hard polyethylene being preferred when higher mechanical strength and lower wear are important, whereas soft polyethylene is employed for the same purpose when the flexibility of the sheath or the covering is more important.

However, since the resistance to stress cracking of products prepared from such materials sometimes leaves something to be desired, it has already been proposed (German Published Specification 2,411,141) that the sheaths of electrical cables or tube bundle cables be prepared from a polyethylene which can be wetted by the action of moisture after grafting on of silane compounds.

However, in sheaths or coverings prepared by this known process, which can be used in the same manner for hard and soft polyethylene, the tear propagation strength, for example, is not always adequate, apart from the techniques, such as cascade arrangements or so-called two-stage processes (German Published Specification 1,794,028), which are relatively complicated and which are necessary for carrying out the moisture crosslinking. Limitations in the storing properties, for example, can arise in the case of the so-called single-stage process (German Published Specification 3,035,709).

So-called facade cables, which serve for current supply and comprise essentially the electrical conductor and an insulating sleeve, are also already known. This sleeve simultaneously also takes on the mechanical function of a protective sheath in addition to the electrical insulation. This poses particular demands on the light resistance and weathering resistance, above all, and also on the mechanical resistance, particularly to thermal cracking and wear, and low temperature stability. In order to fulfil these requirements, high density (0.94-



(0.96 g/cm³) polyolefins which can be crosslinked by the action of moisture after grafting on of silane compounds have already been used (German Published Specification 2,649,874) as material for the covering, to which material
5 1.0 to 8.0% by weight of high-surface-area carbon black has been added.

However, it has been shown that the known measure is not always sufficient to fulfil all the demands simultaneously. Thus, the longitudinal shrinkage, for example,
10 of the covering can occasionally lead to objections if correct location of the end of the cable, guided through the air, in a cable clamp is not possible or if the resistance to deformation of the covering means that a durable retention of the cable end in the clamp is not to
15 be expected under the rapidly changing environmental influences caused by atmospheric conditions. In this connection, the extent to which the covering of the cable retained in the cable clamp is resistant to the action of notching also plays an important role.

20 Plastic pipes, for media transport, which are used everywhere in technology in addition to or as a replacement for metal pipes, have, furthermore, been known for some time. These plastic pipes, for example made from HDPE (high density polyethylene) or also from
25 LDPE (low density polyethylene), can be used for the transport of warm water, such as for heating purposes in the flooring sector, but can also be used for general water supply. If the mechanical strength is more important in the pipes used for media transport, the HDPE is preferred,
30 red, but if higher flexibility is required, for example to simplify the laying of the pipes, then LDPE will be the first choice.

Whichever material is employed for the production of pipes or also tubes, the demand for an adequate resistance to stress cracking, for example, cannot always be fulfilled to an adequate extent.

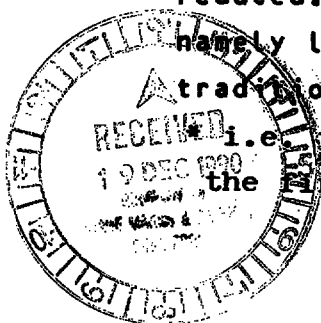
The invention therefore has the object of improving the quality of elongated products, such as electrical cables or lines, external sheaths or insulations, cable-



protecting pipes or media-carrying pipes, manufactured from materials which can be crosslinked using moisture, and simultaneously of simplifying the production, i.e. of making it more economical.

- 5 This object is achieved according to the invention in that the polymer* comprises a linear polymer (or copolymer) of ethylene having a density of 0.88 to 0.95 g/cm³ blended with one or more other polymers(or copolymers); filler material is also included.

 The choice of this specific material, which can
10 be crosslinked by moisture, for example for the external covering of any products or also for the protective pipes of so-called channel pipe-type cables, for lead insulation etc., leads to a significant improvement in quality, also, for example, to an increase in tear propagation strength
15 and also to a significantly greater expansion and thermostability when compared to soft polyethylene. Linear polyethylene, at least insofar as it is in the nature of linear low density polyethylene (LLDPE), combines the characteristic properties of linear low-pressure polyethylene (HDPE -
20 high density polyethylene) with those of highly-branched high-pressure polyethylene (LDPE - low density polyethylene). The structure of the material, employed according to the invention, which is produced by various processes at relatively low pressures, contains, as does HDPE, only
25 very short-chained branches. The main polymer chain is thus, as for HDPE, the determining factor for some significant properties of the macromolecule. Thus, the melting ranges of LLDPE at 120 - 125°C are close to those of HDPE. The number of branches is significantly greater, in
30 contrast to HDPE and, thus, again similar to LDPE. This means that the density and crystallinity are significantly reduced. The designation LLDPE summarizes two properties, namely linear molecular structure and low density, which traditionally appear contradictory.
 i.e. the polymer (or polymeric material) mentioned in the first paragraph of this Description.



Products manufactured from such a material completely fulfil the demands which are set. In particular, it is also possible to use greater amounts of filler, and use is usually made, in the case of the present invention, of 1.5 to 40 parts by weight of filler material per 100 parts by weight of the polymer(s) (or copolymer(s)) employed. Use may for example be made of larger amounts of carbon black, in products according to the invention, than is



6

the case in a conventional homopolymer. This also makes it possible to increase the wear resistance, the thermoforming stability and also the low temperature stability. Along with this, the use of a linear polyethylene here has the further advantage that, in spite of greater amounts of filler, the sheath, the pipe or the insulation, for example, can be produced in one operation, starting from ungrafted base material. During the manufacture of such or similar products according to the invention, lower amounts of silanes and peroxides, which serve for crosslinking, than otherwise usual can be expected, and the crosslinking process in the presence of moisture proceeds faster after grafting of the silane compounds onto the base molecules of linear polyethylene. If the atmospheric humidity is adequately high, the use of saturated steam or water storage can even be avoided. Elongated products according to the invention can therefore also be produced more economically. The material selected according to the invention also permits immediate crosslinking to be dispensed with for products which are provided with an appropriately constructed sheath, and the moisture in the soil leads to crosslinking of the sheath material after laying.

Pipes, pipelines or tubes produced from the material according to the invention are distinguished by greater flexibility compared to the known pipes, while having high strength values. In the case of underfloor heating, for example, this means that significantly smaller bending radii can be employed, and in the so-called low temperature areas, such as in the neighbourhood of windows, it is possible to lay the pipes closer. Clamps or specific embedding systems are largely unnecessary, meaning that the costs can be expected to be more advantageous here too compared to known HDPE pipes, for example.

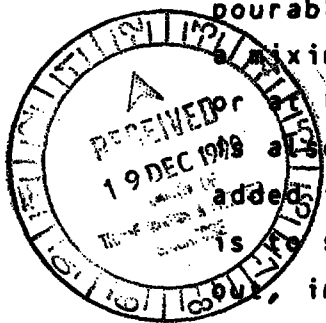
The advantage of improved flexibility also applies to pipe systems, constructed according to the invention, for the general supply of water; thus, these pipelines can be laid without problems, for example in town centres, even in trenches having small radii of curvature.

Connecting elements can thereby be dispensed with. When pipes according to the invention are laid in the ground, the further advantage, compared to HDPE pipes, for example, arises that the silane-crosslinked pipes do not shear off during soil subsidence of any type, but instead adjust themselves to the landslip without problems.

Depending on the manufacturer, a wide variety of types of linear polyethylene are commercially available. However, the linear polyethylenes whose side chains comprise mainly 1-octene, 1-butene or 1-hexene have proven to be the most expedient, also for the special purposes of the invention. The polymer may contain hard or soft polyethylene as a blend component. Similarly, it is also possible to employ a polypropylene as a hard, mechanically stabilizing component for the covering or, when, for example, the flexibility of the cable is more important, to add a certain proportion of ethylene-propylene rubber to the base material.

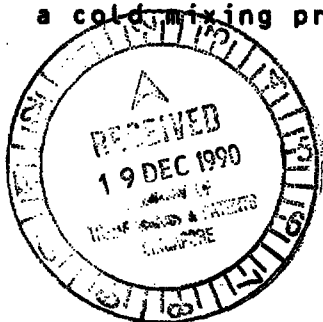
The use of fillers is also possible in an advantageous manner according to the invention. The fillers, such as chalk, are expediently added in such an amount that their proportion in the finished covering is 5 to 40% by weight, preferably 10 to 20% by weight. Because of the crosslinking by moisture which is demanded of the linear polyethylene, it is expedient to use fillers which are sparingly hygroscopic.

For the preparation of an elongated product according to the invention, the silane solution and, if appropriate, further additives, also in liquid form or dissolved in the silane, are advantageously added to the pourable, pulverulent to granular base material during the mixing process at material temperatures which are at least not significantly above room temperature. It is also essential here that the condensation catalyst is added to the base material from the very beginning, that is to say before the grafting of the silane is carried out, in order to achieve a homogeneous distribution. The granulate thus prepared is then grafted in an extrusion process and shaped in the same operation. Such a process ensures that products with good surface quality are



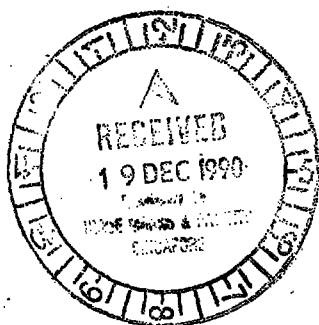
produced and precrosslinking is avoided. However, it has been shown that a polymer material, in this form, which has been initially blended with a filler and granulated and also subsequently wetted with the silane solution only has a relatively short shelf life, and hence is, in general, intended for short-term consumption. This can be a considerable limitation, particularly for the manufacturer and distributor of such mixtures. For this reason, it has proven expedient, according to a further concept of the invention, for fillers and/or pigments and/or carbon black to be added to the base mixture in the form of a highly concentrated pourable mixture (masterbatch) at a point in time after the wetting of the pourable particles of the base materials, at least with the silane solution. This procedure has the advantage that the silane solution is only distributed on the base material. The solid filler concentrates are mixed in after this distribution and partial diffusion, these concentrates being virtually incapable of binding any more silane solution. Mixtures prepared according to this process display unchanging extrudate qualities, even after storage times of several months.

After the diffusion of the silane component, carbon blacks, pigments or other colorants, etc., advantageously in a dosage of 0.1 to 10 parts, relative to 100 parts of base material, or chinks as concentrates can be incorporated at various times. A particularly advantageous possibility is, in continuation of the invention, to add the highly concentrated pourable mixture, for example of a carbon black batch, to the silanized base material after completion of the wetting of the base material, such as of a polyethylene granulate, but still in the same mixing process. This so-called single stage mixing process in a cold mixing process gives rise to a very economic low-



cost process cycle. The carbon black which may be compounded with the polymeric material is preferably a sparingly hygroscopic carbon black, which may be added in a proportion of (e.g.) 1.5 to 15% by weight, preferably 2.5 to 10% by weight.

Another advantageous possibility is, according to a further concept of the invention, not to bring the highly-concentrated pourable mixture together with the silanized base material until in the feed hopper of the



extruder. The considerable diffusion of the silane component into the base material after a certain storage time means that only particles which are already substantially free of silane residues are brought into combination with the filler component at the surface.

The mixer for the base material including the silane solution and, if appropriate, further additives can, however, also be connected directly to the processing extruder. This means that the base polymer is mixed with the silane component and, if appropriate, further additives and is subsequently fed directly into the processing extruder without interim storage.

A further advantageous step in the direction of economic production of a product constructed according to the invention is the addition of the silane, the condensation catalyst and also, if appropriate, further additives in the hopper of the processing extruder, which is constructed as a mixing unit, or even the liquid components are metered directly into the feed system of the processing extruder.

In contrast to the stated possibilities, however, a procedure can also be followed according to the invention whereby the highly-concentrated pourable mixture is added to the silanized base material in a separate subsequent second cold mixing process. The use of these process stages in particular is mainly dependent on the available equipment of the mixture manufacturer or processor.

If the so-called single stage process is preferred, by which the highly-concentrated mixture is added to the base material after completion of the wetting phase, then it has proven expedient for the mixing cycle of base material and silane solution to last 1 to 8 min, preferably 2 to 5 min, at temperatures from 18°C to 40°C. The major part of the silane solution used for the crosslinking is then already distributed homogeneously on the base material, a small remainder, which could still be taken up by the incorporated highly concentrated mixture, is not sufficient to influence the storage time negatively or even to cause incipient crosslinking during grafting and

shaping of the mixture in the extrusion process.

In contrast to the processes described, a procedure can also be carried out without filler batch. The fillers are previously incorporated homogeneously into the entire polymer and the mixture is regranulated. The silane solution, which also contains, for example, the condensation catalyst, is then applied to this mixture. In this type of process, there are limitations regarding storability, selection of fillers and stabilizer systems.

The invention is described in further detail with reference to the illustrative embodiments represented in Fig. 1 to 9.

The Examples which follow additionally illustrate the invention, or are of interest in connection with the invention. (They are marked "Invention" or "Comparison" as the case may be).

Figure 1 shows a so-called 1 kV power distribution cable. This cable comprises four conductors 1, which are stranded together and which are surrounded by the coloured insulating sleeve 2. The internal sheath 3 surrounds the strand group consisting of the leads, and the sheath 4 forms the external, mechanically robust sleeve.

Mixtures of the following composition, for example, can be used for the preparation of the insulation 2:

Example I (Comparison)

Linear polyethylene (density 0.92 g/cm ³)	100 parts
Stabilizer batch	5 parts
Silane	1.2 - 1.6 parts
Peroxide	0.03-0.07 part
Catalyst	0.04-0.08 part
Coloured pigments	0.2 - 5 parts

If a high heat resistance is more important for the insulation of the cable, then the following mixture can be used.

Example II (Comparison)

	Linear polyethylene (density 0.935 g/cm ³)	70 - 80 parts
	HDPE (density 0.950-0.960 g/cm ³)	20 - 30 parts
5	Stabilizer batch	1.1 - 1.5 parts
	Peroxide	0.04-0.08 part
	Catalyst	0.03-0.97 part
	Chalk	5 - 40 parts
	Coloured pigments	0.2 - 5 parts

10 If, in contrast, relatively high flexibility is required,

then the following mixture is preferred:

Example III (Comparison)

15	Linear polyethylene (density 0.917 g/cm ³)	70 - 80 parts
	Ethylene-propylene rubber	20 - 30 parts
	Anti-ageing agent	0.5 part
	Silane	1.4 - 2.0 parts
	Peroxide	0.03-0.06 part
20	Catalyst	0.03-0.07 part
	Coloured pigments	0.2 - 5 parts

25 Vinyl silanes, such as vinyltrimethoxy- or vinyltriethoxysilane, are used as silanes or silane compounds. As peroxides, those which are conventional in silane technology, for example dicumyl peroxide or also bis(tert.-butyl-peroxiisopropyl)benzene, can be used.

30 One or other of the listed mixtures can also be used advantageously for such cables and lines which have to fulfil special requirements in the case of fire. Among these requirements is, for example, that corrosive fumes may not be produced in the case of fire and that equipment which is connected to the cable or the lines must still operate for a certain time in the case of
35 fire (maintenance of operation). The areas of application of such cables and lines are thus, for example, in power stations, ships and platforms, multistorey buildings and hospitals, tunnel installations inter alia.

Fig. 2 shows the single-lead embodiment of a

cable which is constructed correspondingly.

- A glass-mica band 6 is wrapped around the conductor 5, which is constructed from a multitude of individual wires, and an insulating foil 7, for example applied longitudinally, made from a polyethylene glycol terephthalate, the foil being known under the trade name Hostaphan*, covers this band winding. The insulation 8 located above this consists of a linear polyethylene, for example in the mixture composition corresponding to Examples I to III.
- 10 A further insulating foil 9, expediently constructed corresponding to the insulating foil 7, is applied over the insulation 8. 10 denotes a concentric wire layer which is covered by a third insulating foil 11 made from the same material as the insulating foils 7 and 9. The external sheath 12, located on top of this, for example made from halogen-free polyethylene with high filler content, forms the external mechanical protection.

The facade cable according to Fig. 3 consists of the conductor 13, for example prepared from individual wires which are stranded together, which is surrounded by the insulating sleeve 14, which serves both as an insulation and as a sheath. Mixtures of the following composition, for example, can be used for the preparation of the insulating sleeve:

25 Example IV (Comparison)

	Linear polyethylene	
	(density 0.920 g/cm ³)	100 parts
	Stabilizer batch	5 parts
	Silane	1.2 - 1.6 parts
30	Peroxide	0.03-0.07 part
	Catalyst	0.04-0.08 part
	Carbon black batch	6 - 30 parts

If a high heat resistance is more important for the covering of the facade cable, then the following mixture in accordance with the invention can be used:

* Registered Trade Mark

Example V (Invention)

	Linear polyethylene (density 0.935 g/cm ³)	70 - 80 parts
	HDPE (density 0.950-0.960 g/cm ³)	20 - 30 parts
5	Silane	1.1 - 1.5 parts
	Stabilizer batch	5 parts
	Peroxide	0.04-0.08 part
	Catalyst	0.03-0.97 part
	Carbon black batch	5 - 40 parts

10 If, in contrast, relatively high flexibility is required for use of a facade cable constructed according to the invention, then the following mixture is preferred:

Example VI (Invention)

	Linear polyethylene (density 0.917 g/cm ³)	70 - 80 parts
15	Ethylene-propylene rubber	20 - 30 parts
	Anti-ageing agent	0.5 part
	Silane	1.4 - 2.0 parts
	Peroxide	0.03-0.06 part
20	Catalyst	0.03-0.07 part
	Carbon black batch	6 - 35 parts

The following mixture, with a proportion of pale fillers, represents a variation on Example IV in respect of filler content:

25 Example VII (Comparison)

	Linear polyethylene (density 0.920 g/cm ³)	100 parts
	Stabilizer batch	5 parts
	Silane	1.2 - 1.6 parts
30	Peroxide	0.03-0.07 part
	Catalyst	0.04-0.08 part
	Chalk batch	30 parts
	Carbon black batch	6 parts

35 The carbon blacks employed are sparingly hygroscopic, and such carbon blacks are known under the trade names "Benka" or "Akzo Ketjen" Black EC or Acetylen-Noir for example.

Fig. 4 shows a pipeline for the transport of liquid or gaseous media made from a media-carrying inner tube. "Benka" and "Ketjen" are Registered Trade Marks



pipe 15, a heat/cold insulation 16, located above this, and also a pipe 17 which is concentric to the inner pipe 15. The pipes 15 and 17 can consist of plastic and/or of metal, the metal pipes expediently being corrugated.

- 5 The sheath or the protective pipe 18, which, according to the invention, comprises a moisture-crosslinked linear polyethylene*, serves as the external covering.

In contrast to the illustrative embodiment according to Fig. 4, Fig. 5 shows a multi-lead electrical cable. The conductors 19 of the cable consist, for example, of a multitude of individual wires which are stranded together. An insulation 20 is located on top of each of these. The insulated leads are stranded together and covered by an inner sheath 21 and an external sheath 22, which, corresponding to the invention, consists of a linear polymer (or copolymer) of ethylene*.

Fig. 6 shows a construction, which is advantageous because of the moisture crosslinking of the external sheath, of a so-called automation cable, such as is used, for example, in ship electronics. By means of the invention, the construction is significantly more space-saving than that of designs used hitherto. The inner conductors 23 of this cable consist, depending on the demands regarding flexibility, of solid metal wires or metal strands of approximate diameter 0.5 mm. The wires and strands are insulated using thermoplastic polyethylene. The wires or strands provided with this insulation 24 are stranded together into a cable core, a textile or plastic tape lapping 25 being applied over the core as a mechanical protection. The external sheath 26 consists of a linear polyethylene which is crosslinked by moisture.

The Examples VIII to X which follow show the possibilities of mixtures for the embodiments represented in Fig. 4 to 6.

* blended with one or more other polymers (or copolymers), as already specified.

Example VIII (Comparison)

	Linear polyethylene (density 0.92 g/cm ³)	100 parts
	Stabilizer batch	5 parts
5	Silane	1.2 - 1.6 parts
	Peroxide	0.03-0.07 part
	Catalyst	0.04-0.08 part
	Carbon black batch	6 - 30 parts

Example IX (Comparison)

10	Linear polyethylene (density 0.935 g/cm ³)	70 - 80 parts
	HDPE (density 0.950-0.960 g/cm ³)	20 - 30 parts
	Stabilizer batch	1.1 - 1.5 parts
	Peroxide	0.04-0.08 part
15	Catalyst	0.03-0.97 part
	Colour pigments	0.4 - 0.6 part

If, in contrast, relatively high flexibility, for example, is required for use of a sheath constructed according to the invention, then the following mixture

20 is preferred:

Example X (Invention)

	Linear polyethylene (density 0.917 g/cm ³)	70 - 80 parts
	Ethylene-propylene rubber	20 - 30 parts
25	Anti-ageing agent	0.5 part
	Silane	1.4 - 2.0 parts
	Peroxide	0.03-0.06 part
	Catalyst	0.03-0.07 part
	Carbon black batch	6 - 35 parts

30 It can occasionally also be advantageous, depending on the application, to mix flame-retardant additives into the base material, for example a chlorinated polyethylene can be employed as a blend component.

A further advantage of moisture crosslinking, particularly of cable sheaths made from linear polyethylene, arises from the fact that the crosslinking process occurs at or only slightly above room temperature. Cable cores which are thermally very sensitive can thus also be provided with a crosslinked sheath, without danger of

the leads adhering together, which was only possible with great expenditure of time and money in the vulcanization, conventional hitherto, under high steam pressure.

Moisture-crosslinkable linear polyethylenes can also be employed with considerable advantage for those areas of application where petrol- and oil-resistant coverings, or also those with increased temperature stability, are required.

Fig. 7 shows a twin-walled plastic pipe consisting of an inner pipe 27 and an outer pipe 28 enclosing this. The inner pipe 27 consists, according to the invention, for example, of a linear polyethylene of density 0.935 g/cm^3 *, and the outer pipe 28, for example of polypropylene, which takes over the job of a rigid outer sleeve. This rigid outer sleeve is influenced little by the temperatures of the medium to be transported and makes sure that the inner pipe is not widened or destroyed by the operational pressure present, even at elevated temperatures, that is to say $110 - 140^\circ\text{C}$. In place of polypropylene, the pipe 28 can also consist of polyamide, which is, in general, sensitive to hydrolysis and can therefore frequently not be employed as an internal layer, where it comes into contact with the medium to be transported.

In contrast to the illustrative embodiment represented, it is, of course, also possible to select the inner pipe 27 from a suitable material, for example polycarbonate, which is then protected against external chemical influences by a moisture-crosslinked external skin made from linear polyethylene. A metal foil can also advantageously be provided between the two pipes or layers 27 and 28, on the one hand preventing gas permeation, and on the other hand serving as reinforcement for the inner pipe 27 at elevated pressures.

Fig. 8 shows the application of the invention on monitored pipes or pipe systems. In this case, an aluminium foil 31, which is, for example, coated on both sides with plastic, is arranged between the inner pipe 29, made from moisture-crosslinked linear polymers (or copolymers) of ethylene, *

* blended with one or more other polymers (or copolymers), as already specified.

and the outer pipe 30. This foil serves as a diffusion barrier against penetrating or escaping gases.

The outer pipe 30 is covered by a helically corrugated metal pipe 32, which, on the one hand, serves as a mechanical protection, but on the other hand also forms, with the outer pipe 30, a cavity 33 which extends along the pipe system, which cavity can be used as a monitoring space. The monitoring occurs, for example, in that the cavity 33 is subjected to a pressure which is at least 1 bar above the pressure in the inner pipe. The cavity 33 is, furthermore, connected to a suitable pressure monitoring instrument, which gives an alarm if, for example, the pressure in the cavity 33 decreases in the case of a defective inner pipe 29.

Finally, the so-called remote heat conductance pipe is represented in Fig. 9. This remote heat conductance pipe consists of an inner plastic pipe 34 made from a linear polyethylene, which is crosslinked by the action of moisture. The inner pipe 34 is enveloped by an aluminium foil 35 having an overlapping seam 36. A further plastic layer 37, which can also consist of a moisture-crosslinked linear polyethylene, is extruded onto the aluminium foil 35. The aluminium foil 35 is coated on both sides with copolymer, so that it adheres both to the inner pipe 34 and also to the outer plastic layer 37, including the longitudinal seam 36, during the extrusion of the outer plastic layer 37. A heat insulation layer 38 based on expanded polyurethane encloses the plastic layer 37, the constant wall thickness of the heat insulation layer being ensured by a spacer, not represented. A flexible closed-cell polyurethane foam having a maximum thermal conductivity of 0.03 W/mh is expediently used as material for the heat insulation layer 38.

The heat insulation layer 38 is surrounded by a further aluminium foil 39 which has an overlapping seam 40. The aluminium foil 39 is provided, at least on the surface facing the heat insulation layer 38, with a copolymer coating, which allows the aluminium foil 39 to adhere to the layer 38 and simultaneously ensures adherence of

the longitudinal seam 40. An extruded plastic pipe 41, which is expediently also prepared from a linear polyethylene and which is crosslinked by the action of moisture, serves as the external sheath.

- 5 The Examples XI to XIII which follow show possible mixtures for the pipelines represented in Fig. 7 to 9.

Example XI (Comparison)

Linear polyethylene	
10 (density 0.935 g/cm ³)	100 parts
Stabilizer batch	5 parts
Silane	1.2 - 1.6 parts
Peroxide	0.03-0.07 part
Catalyst	0.04-0.08 part

- 15 Such a naturally-coloured pipe is expediently used as the inner pipe of pipelines where UV stability is not important, or is also employed as a hot water pipe for underfloor heating.

- 20 If, in contrast, UV stability and, in addition, relatively high heat resistance are important, then the following mixture can be used:

Example XII (Comparison)

Linear polyethylene	
(density 0.935 g/cm ³)	70 - 80 parts
25 HDPE (density 0.950-0.960 g/cm ³)	20 - 30 parts
Stabilizer batch	1.1 - 1.5 parts
Peroxide	0.04-0.08 part
Catalyst	0.03-0.97 part
Carbon black batch	6 - 8 parts

- 30 If, in contrast, a relatively high flexibility is required,

without taking UV stability into account, the following mixture will be preferred:

Example XIII (Invention)

Linear polyethylene		
(density 0.92 g/cm ³)		70 - 80 parts
Ethylene-propylene rubber		20 - 30 parts
5	Anti-ageing agent	0.5 part
	Silane	1.4 - 2.0 parts
	Peroxide	0.03-0.06 part
	Catalyst	0.03-0.97 part
	Chalk batch	5 - 15 parts

- 10 Vinyl silanes, such as vinyltrimethoxy- or vinyltriethoxysilane, are also used as silanes or silane compounds in these examples. The carbon blacks employed are sparingly hygroscopic, such carbon blacks being known, for example, under the trade names Denkablack*,
- 15 Akzo Ketjen*Black EC or Acetylen-Noir Y. The peroxides which are conventional in silane technology, such as, for example, dicumyl peroxide or also bis(tert.-butylperoxyisopropyl)benzene, can be used as peroxides.

It will be understood that the invention has been described above purely by way of example, and that various modifications of detail can be made within the ambit of the invention.

* "Denka" and "Ketjen" are Registered Trade Marks

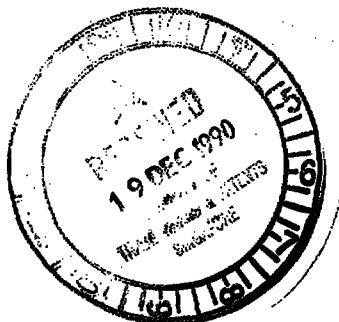
CLAIMS

1. Elongated product made from a composition comprising a polymer which is crosslinked by grafted-on unsaturated vinyl silane compounds under the action of moisture, or made from layers containing such material, for example electrical cables or media-carrying pipes, wherein the said crosslinked polymer comprises a linear polymer (or copolymer) of ethylene having a density of 0.88 to 0.95 g/cm³, blended with one or more other polymers (or copolymers), together with filler material.
2. Elongated product according to claim 1, characterized in that the filler material amounts to 1.5 to 40, preferably 20-30, parts by weight per 100 parts by weight of the polymer (or copolymer) blend.
3. Elongated product according to claim 1 or 2, characterized in that the side chains of the linear polyethylene comprise mainly 1-octene, 1-butene or 1-hexene.



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4. Elongated product according to Claim 1, 2 or 3, characterized in that the polymer contains hard or soft polyethylene as a blend component.
5. Elongated product according to Claim 1, 2, 3 or 4, characterized in that the polymer contains polypropylene or ethylene-propylene rubber as a blend component.
6. Elongated product according to any of the preceding claims, characterized in that the polymer contains a sparingly hygroscopic carbon black.
7. Elongated product according to Claim 6, characterized in that 1.5 to 15% by weight, preferably 2.5 to 10% by weight, of carbon black are added.
8. Elongated product according to any of the preceding claims, characterized in that the polymer contains sparingly hygroscopic fillers of the order 5 to 40% by weight, preferably 10 to 20% by weight.
9. Elongated product according to any of the preceding claims, characterized in that the polymer contains pigments or other colorants in a dosage of 0.1 to 10 parts, relative to 100 parts of base material in each case.



10. Process for the preparation of an elongated product according to Claim 1, characterized in that the silane solution and, if appropriate, further additives, also in liquid form or dissolved in the silane, are added to the pourable, pulverulent to granular polymeric material during a mixing process at material temperatures which are at or at least not significantly above room temperature.

11. Process according to Claim 10, characterized in that fillers and/or pigments and/or carbon black, in the form of a highly concentrated pourable mixture (master batch) are added to the base mixture at a point in time after the wetting of the pourable particles of the base materials, at least with the silane solution.

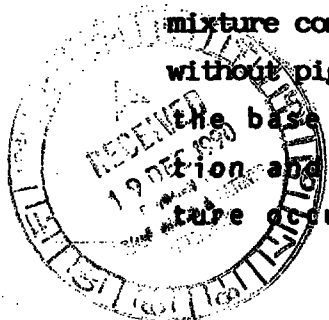
12. Process according to Claim 11, characterized in that the highly concentrated pourable mixture is only added to the base material, wetted by the silane solution, at the end of the mixing phase, but still in the same mixing process.

13. Process according to Claim 11, characterized in that the highly concentrated pourable mixture is brought together with the base material, wetted by the silane solution, in the feed hopper of an extruder.

14. Process according to Claim 11, characterized in that the highly concentrated pourable mixture is added to the base material, wetted by the silane solution, after partial diffusion of the solution into the powder or granulate in a separate subsequent second cold mixing process.

15. Process according to Claim 12, characterized in that the mixing phase lasts 1 to 8 min, preferably 2 to 5 min, at temperatures from 18° to 40°C.

16. Process for the preparation of an elongated product according to Claim 1, in which a highly-concentrated mixture containing carbon black and/or other filler material, with or without pigments, is incorporated into the base material, characterized in that the incorporation and homogenization of the highly-concentrated mixture occur directly into the base material and it is



only wetted by the silane compounds or the additives dissolved in the silane after regranulation of the mixture has taken place.

17. Process for the preparation of an elongated product according to Claim 1, in which the polymeric material, including the silane solution, is mixed and subsequently fed to a processing extruder, characterized in that the polymeric material, which is mixed with the silane solution and, if appropriate, further additives, is introduced directly into the processing extruder without interim storage.

18. Process according to any of claims 10 to 17, characterized in that the silane solution, including, if appropriate, further additives, is added in the hopper of a processing extruder, which is constructed as a mixing unit.

19. Process for the preparation of an elongated product according to Claim 1, characterized in that the silane solution, including, if appropriate, further additives, is metered directly into the feed system of a processing extruder.

20. Process according to any of claims 10 to 19, characterized in that the silane solution also contains the condensation catalyst which is necessary for the moisture-crosslinking.

21. Process according to claim 10, 16, 17 or 19, wherein the base material employed has a formulation substantially as indicated in Example V, VI, X or XIII.

22. An elongated product prepared by a process according to any of claims 10 to 21.

23. An elongated product according to claim 1, substantially as described with reference to any Figure of the accompanying drawings.

