

Description

The present invention relates to a magnet wire excellent in windability, lubricity, and abrasion resistance, which keeps its insulating film undamaged when wound into a coil, thereby contributing to improved productivity and yield of coil making.

Electrical equipment has been recently made compact and improved in performance and, in addition, at reduced cost. Along with these tendencies, the fabrication process has been systemized and simplified, and material cost has been reduced.

In the fabrication process of coils for motors, transformers, and the like, all of which play important roles in electrical equipment, an improvement in productivity by a high-speed coil winding process and an improvement in motor performance by an increase in occupation ratio of a magnet wire in a stator slot in a motor cause extensive studies in the advancement of compact arrangements. The systemization and simplification of the process for fabricating coils for motors, transformers, and the like as well as the compact configuration of electrical equipment impose severe conditions on magnet wire coatings used therein. For example, in the coil winding process, magnet wires tend to be brought into contact with pulleys, guides or the like in high-speed coil winding by an automatic winder. In addition, wire tension during the winding process is increased. The insulating coating tends to be damaged, thus causing defects such as a rare short.

Contact forces between magnet wires, between the magnet wire and a core, and between the magnet wire and an inserter blade are increased by an increase in occupation ratio in the stator slot of the motor and by introduction of an automatic inserter. The increases in contact forces mainly cause occurrence of defects. In order to prevent damage to the insulating film during the conventional coil winding process, an oil, paraffin wax or the like is coated on the insulating film to reduce a coefficient of friction thereof. However, such a conventional method cannot solve the above disadvantages.

U.S. Patent No. 3,413,148 proposes a technique wherein a thin polyethylene layer is formed on a surface of an insulating film. This technique is effected to reduce the coefficient of friction to some extent, but is not expected to greatly improve the abrasion resistance of the insulating film. U.S. Patent Nos. 3,775,175, 4,390,590 and 4,378,407, British Patent No. 2,103,868, and Japanese Patent Publ. No. 9392/78 propose techniques wherein a lubricant is added to or reacts with an insulating enamel to reduce a coefficient of friction so as to improve lubricity of the insulating film itself. These techniques have effects to some extent, but do not essentially prevent damage to the insulating film.

In order to overcome the disadvantages of the conventional techniques, the coefficient of friction must be greatly reduced, and abrasion resistance must be greatly improved.

US-A-4 350 738 discloses a mixture comprising natural wax as a major constituent as lubricant for lubricant coated insulated magnet wire of improved windability. From FR-A-2 031 391 it is further known to use in the production of insulated wires a fluorocarbon, namely PTFE as the lubricant.

It is an object of the present invention to provide a magnet wire having a lubricant layer whose lubricity and abrasion resistance are greatly improved.

The present invention comprises an excellent windability magnet wire wherein an insulating layer of a synthetic resin film is formed on a conductor directly or with another insulation in between and a lubricant layer comprising a wax as major constituent mixture is formed on the insulating layer, characterized in that the lubricant layer has a thickness in the range of 0.2 to 2 μm , and is made of an intimate mixture prepared by adding 1 to 30 parts by weight of a fluorocarbon resin into 100 parts by weight of a natural wax and a thermosetting resin, the mixing ratio of the natural wax to the thermosetting resin in the lubricant layer being 80/20 to 60/40 by weight.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a cross-sectional view of an excellent windability magnet wire according to the present invention;

Fig. 2 is a plan view of equipment for coefficient of static friction so as to measure coefficients of static friction of excellent windability magnet wires of the present invention; and

Fig. 3 is a side view of the equipment shown in Fig. 2.

Natural wax used in the present invention can be preferably emulsified in water and preferably has high hardness. Examples of natural wax are carnauba wax, montan wax, bees wax, rice wax, and candelilla wax. Among these waxes, carnauba, montan and bees waxes have very high hardness and can be preferably used in the present invention.

A thermosetting resin used in the present invention is preferably soluble or emulsified in water. Examples of the thermosetting resin are an ammonium or alcohol solution of shellac, a water dispersion of acrylic resin, and an aqueous solution of water soluble phenolic resin. Among these resins, shellac and water soluble phenolic resin are the most preferable because the abrasion resistance of the resultant magnet wire is excellent and the preparation of its solution is easy.

A fluorocarbon resin used in the present invention preferably has a high content of fluorine. Examples of the fluorocarbon resin are polytetrafluoroethylene (PTFE), a fluorinated ethylene-propylene copolymer (FEP), and polytrifluorochloroethylene (PTFCE). Polytetrafluoroethylene and fluorinated ethylene-propylene copolymer are the most preferable. These fluorocarbon resins must be used in a form dispersed

or emulsified in water and can be used as a commercially available dispersed or emulsified form of resin. Examples of PTFE water dispersion are T30J (trade name) available from DuPont-Mitsui Fluorochemical Co., Ltd., and AS COAT Nos. 5, 6, and 20 (trade names) available from SATO, K. K. An example of FEP water dispersion is T120 (trade name) available from DuPont-Mitsui Fluorochemical Co., Ltd.

A weight ratio of natural wax to thermosetting resin as the constituting components in the lubricant layer is 80/20 to 60/40 and most preferably 75/25 to 65/35. If the content of natural wax exceeds 80 parts by weight, the abrasion resistance of the resultant magnet wire is slightly degraded. If the content of natural wax is less than 60 parts by weight, lubricity of the resultant wire is degraded.

The content of the fluorocarbon resin for 100 parts by weight of natural wax and thermosetting resin is 1 to 30 parts by weight and, most preferably 7 to 20 parts by weight. If the content of the fluorocarbon resin is less than 1 part by weight, the abrasion resistance and lubricity of the magnet wire are degraded. If the content of the fluorocarbon resin exceeds 30 parts by weight, an adhesion property between the insulating layer and the lubricant layer is degraded.

A preparation method of a lubricant paint used to form the lubricant layer having the above composition is exemplified as follows.

A predetermined amount of natural wax is mixed with a small amount of an emulsifier (surfactant), required for emulsifying the natural wax, such as polyoxyethylene alkylether or sorbitane monoalkylester, and the resultant mixture is heated and melted. Water is added to the melt, and the resultant mixture is heated and then cooled to prepare an emulsion. A thermosetting resin solution or dispersion is added to the emulsion, and a water dispersion of a fluorocarbon resin is added to the resultant mixture. The mixture is stirred at a high speed by a homogenizer to obtain a uniform lubricant paint. Such a lubricant paint may be obtained by adding a water dispersion of a fluorocarbon resin in a commercially available mixing dispersion of natural wax and thermosetting resin.

The concentration of the resultant lubricant layer paint is controlled to be 5 to 15%. The paint is continuously applied to the insulating layer by die or felt coating and is hardened when the paint passes through a furnace at a temperature of 200 to 600°C. The thickness of the lubricant layer is 0.2 to 2.0 μm . If the thickness of the lubricant layer is less than 0.2 μm , lubricity is excellent but the improvement of abrasion resistance is degraded. However, if the thickness exceeds 2.0 μm , the property of adhesion between the insulating layer and the lubricant layer, and therefore the abrasion resistance are degraded.

The thickness of the lubricant layer is most preferably 0.5 to 1.0 μm .

Examples of the resin for forming an insulating layer on the magnet wire in the present invention are polyvinylformal, polyester, polyesterimide, polyesteramidimide, polyamidimide, polyimide, polyhydantoin, polyurethane, polyamide, epoxy, acrylic and polyetherimide. Such a resin is applied by enamel coating-and-baking, extrusion coating, powder coating, or electrodeposition coating. In this case, the insulating layer consists of a single layer of a resin or a multilayer of at least two resins.

Examples 1—7 and Comparative Examples 1—14

100 parts by weight of carnauba wax No. 1, 3 parts by weight of sorbitane mono-oleate, 2 parts by weight of polyoxyethylene stearyl ether were melted at 100°C, and the resultant melt was poured in boiling water stirred at high speed. When the solution was stirred uniformly, the stirred solution was cooled to obtain a carnauba wax emulsion. An ethyl alcohol solution of shellac and a water dispersion of polytetrafluoroethylene (PTFE) T30J (trade name) available from DuPont-Mitsui Fluorochemical Co., Ltd. were added to the carnauba wax emulsion, and the resultant mixture was uniformly homogenized by a homogenizer to prepare a lubricant layer paint (A) having a mixing ratio of carnauba wax/shellac/PTFE being 70/30/10 and having a concentration of 7.5%.

40- μm thick insulating layers 2 were respectively formed on copper wires 1 each having a diameter of 1.0 mm by using various coating materials and methods shown in Table 1. The lubricant layer paint (A) was applied to the respective insulating layers and was baked thereon in a baking furnace having a furnace temperature of 400°C and a furnace length of 4 m at a rate of 12 m/min, thereby forming 0.7- μm thick lubricant layers 3 (Fig. 1).

In order to check the properties of the resultant magnet wires, the abrasion resistances and dielectric strengths were measured according to NEMA MW1000 and JIS C3003 and coefficients of friction were measured according to DIN 46453. In addition, by using equipment for coefficient of static friction shown in Figs. 2 and 3, coefficients of static friction of the wires were measured. The measurement results are summarized in Table 2.

Various types of magnet wires (Comparative Examples 1, 3, 5, 7, 9, 11, and 13) without the lubricant layers shown in Table 1 and wires (Comparative Examples 2, 4, 6, 8, 10, 12 and 14) obtained by a conventional method for applying paraffin wax (melting point of 60°C) shown in Table 1 to the corresponding insulating layers were prepared for comparison. The properties of the resultant wires were measured in the same manner as in the examples. Results are summarized in Table 2. The coefficients of static friction of the wires were measured as coefficients of interline friction by using equipment shown in Figs. 2 and 3 in the following manner. Two parallel sample wires 5 were attached to metal block 4 having a predetermined load and were placed on two parallel sample wires 7 placed on glass plate 6. Wires 5 were perpendicular to wires 7. The weight of counterweight 9 connected to the distal end of lead wire 8, the

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proximal end of which was connected to block 4, was increased until block 4 started to move. The coefficients of static friction were calculated by the following equation:

$$\mu = \frac{\text{(Coefficient of Static Friction)} \mu = \text{(Weight of Counterweight when Block Started to Move) (g)} / \text{(Weight of Block) (g)}}{5}$$

10

15

20

25

30

35

40

45

50

55

60

65

TABLE 1

Insulating Layer Forming Method	Enamel Coating and Baking						Powder Coating	Extrusion Coating
	Polyester	Polyester-imide	Polyamide-imide	Polyimide	Polyamideimide-overcoated Polyesterimide	Epoxy		
Resin								
With Lubricant Layer	Example 1	" 2	" 3	" 4	" 5	" 6	" 7	
Without Lubricant Layer	Comparative Example 1	" 3	" 5	" 7	" 9	" 11	" 13	
Paraffin Wax (m.p. 60°C)	Comparative Example 2	" 4	" 6	" 8	" 10	" 12	" 14	

* Polyester: Isonel 200 (trade name) available from Nisshoku Schenectady Chemicals Inc.

* Polyesterimide: Isomid (trade name) available from Nisshoku Schenectady Chemicals Inc.

* Polyamideimide: HI405 (trade name) available from Hitachi Chemical Co., Ltd.

* Polyimide: Pyre-ML (trade name) available from E.I. DuPont de Nemours Co., USA

* Epoxy: XR5256 (trade name) available from 3M Co., USA

* Polyetherimide: ULTEM (registered trade mark) available from General Electric Co., USA

TABLE 2

Example and Comparative Example	Abrasion Resistance		Coefficient of friction		Dielectric Strength (KV)
	Unidirectional (g) (NEMA NW1000)	Repeated (Strokes) (JIS C3003)	According to Figs. 2 and 3	DIN 46453	NEMA MW1000
Example 1	1610	540	0.027	0.17	13.8
Comparative Example 1	1405	32	0.145	0.28	13.9
Comparative Example 2	1450	65	0.086	0.26	13.5
Example 2	1680	609	0.028	0.16	15.0
Comparative Example 3	1420	54	0.137	0.25	14.8
Comparative Example 4	1420	76	0.080	0.23	14.8
Example 3	2030	790	0.026	0.16	15.5
Comparative Example 5	1530	220	0.150	0.28	15.0
Comparative Example 6	1590	240	0.075	0.28	15.5
Example 4	2020	860	0.030	0.17	14.7
Comparative Example 7	1450	65	0.158	0.29	14.6
Comparative Example 8	1510	80	0.081	0.25	15.0
Example 5	1990	750	0.026	0.18	15.0
Comparative Example 9	1510	180	0.139	0.27	15.5
Comparative Example 10	1520	183	0.075	0.25	14.7
Example 6	1730	437	0.031	0.19	12.1
Comparative Example 11	1400	28	0.178	0.28	10.9
Comparative Example 12	1430	30	0.101	0.24	11.7
Example 7	1705	363	0.033	0.19	13.7
Comparative Example 13	1350	37	0.135	0.29	13.5
Comparative Example 14	1380	40	0.090	0.28	13.8

As is apparent from Table 2, the abrasion resistances and lubricity of the magnet wires according to the present invention are far better than the conventional magnet wires without lubricant layers and with paraffin wax coatings, and the electrical characteristics of the magnet wires of the present invention are equivalent or better than those of the conventional magnet wires.

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Examples 8—11

A polyamideimide paint used in the previous examples was applied and baked to form 40- μ m thick insulating layers on copper wires. Following the same procedures as in the previous examples, the lubricant layer paint (A) was applied to the insulating layers to form 0.1-, 0.3-, 1.8-, and 2.5- μ m thick lubricant layers thereon.

Following the same procedures as in Examples 1 to 7, the properties of the resultant magnet wires were measured, and the test results are shown in Table 3. The properties of the wire in Example 3 (thickness of the lubricant layer is 0.7 μ m) are also listed in Table 3.

TABLE 3

Example	Lubricant Layer	Abrasion Resistance		Coefficient of friction		Dielectric Strength (KV)
	Thickness (μ m)	Unidirectional (g) (NEMA NW1000)	Repeated (Strokes) (JIS C3003)	According to Figs. 2 and 3	DIN 46453	NEMA MW1000
8	0.1	1730	420	0.034	0.23	14.9
9	0.3	1950	730	0.027	0.15	14.9
10	1.8	1960	690	0.026	0.17	15.8
11	2.5	1760	480	0.029	0.20	14.7
3	0.7	2030	790	0.026	0.16	15.5

As is apparent from Table 3, when the thickness of the lubricant layer is less than 0.2 μ m or exceeds 2.0 μ m, the abrasion resistance is degraded.

Examples 12—23

Lubricant layer paints (B) to (M) were prepared. The same emulsifier for natural wax and the same emulsifying method as in the preparation of the paint (A) were used. Compositions of paints (B) to (M) are summarized in Table 4. Shellac was added in the form of an ethyl alcohol solution, and water-soluble phenolic resin was added as a deionized aqueous solution. The concentration of each paint was 7.5%. The resultant paints (B) to (M) were applied to and baked on polyamideimide-coated magnet wires each having a diameter of 1.0 μ m to form 0.7- μ m thick lubricant layers, following the same procedures as in Example 3. The properties of the resultant magnet wires were measured in the same manner as in Example 1, and results are summarized in Table 5.

TABLE 4

(Unit: Solid weight ratio)													
		B	C	D	E	F	G	H	I	J	K	L****	M****
Natural Wax	Carnauba Wax	85	78	55		70	70	70	70	70	70	100	100
	Montan Wax				70								
Thermo-setting Resin	Shellac	15	22	45	30		30	30	30	30	30	100	100
	Water-Soluble Phenol Resin*					30							
Fluoro-carbon Resin	PTFE**	10	10	10	10	10		2	0.5	27	40	10	
	FEP***						10						10

*: J-303 (trade name) available from DAINIPPON INK & CHEMICALS INC.

** : T30J (trade name) available from DuPont-Mitsui Fluorochemical Co., Ltd.

***: T120 (trade name) available from DuPont-Mitsui Fluorochemical Co., Ltd.

**** L,M: TEC9601 (trade name) available from Toshiba Chemical Products Co., Ltd. and used as an intimate mixture of carnauba wax and shellac

TABLE 5

Example	Lubricant Layer Paint	Abrasion Resistance		Coefficient of friction		Dielectric Strength (KV)
		Unidirectional(g) (NEMA NW1000)	Repeated(strokes) (JIS C3003)	According to Figs. 2 and 3	DIN 46453	NEMA MW1000
12	B	1710	280	0.029	0.18	14.9
13	C	2010	750	0.026	0.17	15.1
14	D	1870	450	0.049	0.23	15.1
15	E	2000	760	0.027	0.17	14.8
16	F	2150	690	0.025	0.18	14.5
17	G	1930	630	0.025	0.16	15.3
18	H	1910	550	0.031	0.20	15.0
19	I	1680	350	0.041	0.28	14.6
20	J	2150	860	0.024	0.16	14.5
21	K	1630	290	0.029	0.18	14.1
22	L	2060	780	0.026	0.16	15.5
23	M	1950	690	0.026	0.16	15.1

As shown in Examples 12 to 23, when the content of natural wax exceeded 80 parts by weight with respect to 100 parts by weight of the mixture of natural wax and thermosetting resin, the improvement of abrasion resistance was degraded. However, if the content of natural wax was less than 60 parts by weight, the improvement of lubricity was degraded.

If the content of fluorocarbon resin was less than 1 part by weight with respect to 100 parts by weight of the mixture of natural wax and thermosetting resin, the abrasion resistance and lubricity were degraded. If the content of fluorocarbon resin exceeded 30 parts by weight, the abrasion resistance was degraded.

Example 24

One hundred parts by weight of fine alumina powder having a particle size of 1 to 6 μm and 90 parts by weight of a silicone resin solution (TRS116: trade name available from Toshiba Silicone Co., Ltd.) were put into a ball mill and were mixed for about 4 hours, thus obtaining a silicone resin paint compounded with an

inorganic material. The resultant paint was applied to a nickel-plated copper wire having a diameter of 1.0 mm according to die coating and was baked in a furnace having a length of 4 m and a temperature of 400°C at a rate of 8 m/min, thereby obtaining a 30- μ m thick inorganic insulating layer. A polyamideimide paint as in Example 3 was applied and baked on the inorganic insulating layer to form a 10- μ m polyamideimide resin layer thereon.

Following the same procedures as in Example 1, the lubricant layer paint (A) was applied to and baked on the resultant magnet wire. The properties of the resultant magnet wires were measured in the same manner as in Examples 1 to 23, and results are summarized in Table 6. The properties of the conventional wires without the lubricant layers are also listed in Table 6.

TABLE 6

Lubri- cant Layer	Abrasion Resistance		Coefficient of friction		Dielectric Strength (KV)
	Unidirec- tional (g) (NEMA NW1000)	Repeated (strokes) (JIS C3003)	According to Figs. 2 and 3	DIN 46453	
No	1670	153	0.14	0.28	7.8
Yes	2010	530	0.026	0.16	8.0

As is apparent from Table 6, the magnet wires of a composite inorganic-organic material according to the present invention have excellent properties such as high abrasion resistance and good lubricity.

Claims

1. An excellent windability magnet wire wherein an insulating layer of a synthetic resin film is formed on a conductor directly or with another insulation in between and a lubricant layer comprising a wax as major constituent mixture is formed on the insulating layer, characterized in that the lubricant layer has a thickness in the range of 0.2 to 2 μ m and is made of an intimate mixture prepared by adding 1 to 30 parts by weight of a fluorocarbon resin into 100 parts by weight of a natural wax and a thermosetting resin, the mixing ratio of the natural wax to the thermosetting resin in the lubricant layer being 80/20 to 60/40 by weight.

2. A wire according to claim 1, characterized in that the fluorocarbon resin is at least one resin selected from the group consisting of polytetrafluoroethylene and a fluorinated ethylenepropylene copolymer.

3. A wire according to claim 1, characterized in that the natural wax is at least one wax selected from the group consisting of carnauba wax and montan wax.

4. A wire according to claim 1, characterized in that the thermosetting resin is at least one resin selected from the group consisting of shellac and water-soluble phenol resin.

5. A wire according to claim 1, characterized in that the insulating layer of the synthetic resin film comprises a resin selected from the group consisting of polyvinylformal, polyester, polyesterimide, polyesteramideimide, polyamideimide, polyimide, polyhydantoin, polyurethane, polyamide, epoxy, acrylic and polyetherimide.

6. A wire according to claim 1, characterized in that the insulating layer of the synthetic resin film comprises a multilayer made of at least two resins selected from the group consisting of polyvinylformal, polyester, polyesterimide, polyesteramideimide, polyamideimide, polyimide, polyhydantoin, polyurethane, polyamide, epoxy, acrylic and polyetherimide.

7. A wire according to claim 1, characterized in that the synthetic resin insulating layer is formed by one process selected from the group consisting of enamel coating-and-baking, powder coating, extrusion coating, or electrodeposition coating of an insulating paint.

Patentansprüche

1. Magnetdraht mit ausgezeichneter Aufwickelbarkeit, bei dem eine Isolierschicht aus einem synthetischen Harzfilm direkt auf einem Leiter oder mit einer anderen Isolierung dazwischen ausgebildet ist, und eine Schmiermittelschicht, welche Wachs als Hauptmischungsbestandteil enthält, auf der Isolierschicht ausgebildet ist, dadurch gekennzeichnet, daß die Schmiermittelschicht eine Dicke im Bereich von 0,2 bis 2 μ m, hat, und hergestellt wurde aus einer innigen Mischung, die erhalten wurde durch Zugabe von 1 bis 30 Gew.-Teilen eines Fluorkohlenstoffharzes zu 100 Gew.-Teilen eines natürlichen Wachses und



inorganic material. The resultant paint was applied to a nickel-plated copper wire having a diameter of 1.0 mm according to die coating and was baked in a furnace having a length of 4 m and a temperature of 400°C at a rate of 8 m/min, thereby obtaining a 30- μ m thick inorganic insulating layer. A polyamideimide paint as in Example 3 was applied and baked on the inorganic insulating layer to form a 10- μ m polyamideimide resin layer thereon.

Following the same procedures as in Example 1, the lubricant layer paint (A) was applied to and baked on the resultant magnet wire. The properties of the resultant magnet wires were measured in the same manner as in Examples 1 to 23, and results are summarized in Table 6. The properties of the conventional wires without the lubricant layers are also listed in Table 6.

TABLE 6

Lubricant Layer	Abrasion Resistance		Coefficient of friction		Dielectric Strength (KV)
	Unidirectional (g) (NEMA NW1000)	Repeated (strokes) (JIS C3003)	According to Figs. 2 and 3	DIN 46453	NEMA MW1000
No	1670	153	0.14	0.28	7.8
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3. A wire according to claim 1, characterized in that the natural wax is at least one wax selected from the group consisting of carnauba wax and montan wax.

4. A wire according to claim 1, characterized in that the thermosetting resin is at least one resin selected from the group consisting of shellac and water-soluble phenol resin.

5. A wire according to claim 1, characterized in that the insulating layer of the synthetic resin film comprises a resin selected from the group consisting of polyvinylformal, polyester, polyesterimide, polyesteramideimide, polyamideimide, polyimide, polyhydantoin, polyurethane, polyamide, epoxy, acrylic and polyetherimide.

6. A wire according to claim 1, characterized in that the insulating layer of the synthetic resin film comprises a multilayer made of at least two resins selected from the group consisting of polyvinylformal, polyester, polyesterimide, polyesteramideimide, polyamideimide, polyimide, polyhydantoin, polyurethane, polyamide, epoxy, acrylic and polyetherimide.

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Patentansprüche

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eines wärmehärtbaren Harzes, wobei das Mischungsverhältnis des natürlichen Wachses zu dem wärmehärtbaren Harz in der Schmiermittelschicht 80/20 bis 60/40, auf das Gewicht bezogen, beträgt.

2. Harz gemäß Anspruch 1, dadurch gekennzeichnet, daß das Fluorkohlenstoffharz wenigstens ein Harz, ausgewählt aus der Gruppe bestehend aus Polytetrafluorethylen und einem fluorierten Ethylen-Propylen-Copolymer ist.

3. Harz gemäß Anspruch 1, dadurch gekennzeichnet, daß das natürliche Wachs wenigstens ein Wachs, ausgewählt aus der Gruppe bestehend aus Carnauba-Wachs und Montan-Wachs ist.

4. Harz gemäß Anspruch 1, dadurch gekennzeichnet, daß wärmehärtbare Harz wenigstens ein Harz, ausgewählt aus der Gruppe bestehend aus Schellack und wasserlöslichem Phenolharz ist.

5. Draht gemäß Anspruch 1, dadurch gekennzeichnet, daß die Isolierschicht aus dem synthetischen Harzfilm ein Harz umfaßt, das ausgewählt ist aus der Gruppe bestehend aus Polyvinylformal, Polyester, Polyesterimid, Polyesteramidimid, Polyamidimid, Polyimid, Polyhydantoïn, Polyurethan, Polyamid, Epoxy, Acryl und Polyetherimid.

6. Draht gemäß Anspruch 1, dadurch gekennzeichnet, daß die Isolierschicht des synthetischen Harzfilms eine Mehrschicht umfaßt, die aus wenigstens zwei Harzen hergestellt wurde, ausgewählt aus der Gruppe bestehend aus Polyvinylformal, Polyester, Polyesterimid, Polyesteramidimid, Polyamidimid, Polyimid, Polyhydantoïn, Polyurethan, Polyamid, Epoxy, Acryl und Polyetherimid.

7. Harz gemäß Anspruch 1, dadurch gekennzeichnet, daß die Isolierschicht aus synthetischem Harz mittels eines Verfahrens ausgebildet wurde, das ausgewählt ist aus der Gruppe, bestehend aus Lacküberziehen und -einbrennen, Pulverbeschichten, Extrusionsbeschichten oder Beschichten durch Elektroabscheidung eines Isolieranstrichs.

Revendications

1. Fil à bobiner, présentant une excellente aptitude à l'enroulement, dans lequel une couche isolante constituée d'un film de résine synthétique est formée sur un conducteur, directement ou par-dessus une autre couche isolante intermédiaire, et une couche lubrifiante, comprenant une cire comme constituant majeur de mélange, est formée par-dessus la couche isolante, le fil étant caractérisé en ce que la couche lubrifiante présente une épaisseur située dans l'intervalle de 0,2 à 2 µm et qu'elle est constituée d'un mélange homogène préparé par addition de 1 à 30 parties en poids d'une résine fluorocarbonée dans 100 parties en poids d'une cire naturelle et d'une résine thermodurcissable, les proportions pondérales de mélange de la cire naturelle à la résine thermodurcissable dans la couche lubrifiante valant de 80/20 à 60/40.

2. Fil conforme à la revendication 1, caractérisé en ce que la résine fluorocarbonée est au moins une résine choisie dans le groupe constitué du polytétrafluoroéthylène et d'un copolymère fluoré d'éthylène et de propylène.

3. Fil conforme à la revendication 1, caractérisé en ce que la cire naturelle est au moins une cire choisie dans le groupe constitué de la cire de carnauba et de la cire de lignite.

4. Fil conforme à la revendication 1, caractérisé en ce que la résine thermodurcissable est au moins une résine choisie dans le groupe constitué du shellac et d'une résine phénolique hydrosoluble.

5. Fil conforme à la revendication 1, caractérisé en ce que la couche isolante constituée d'un film de résine synthétique comprend une résine choisie dans le groupe constitué du poly(formal de vinyle), d'un polyester, d'un polyester-imide, d'un polyester-amide-imide, d'un polyamide-imide, d'un polyimide, d'une polyhydantoïne, d'un polyuréthane, d'un polyamide, d'une résine époxy, d'une résine acrylique et d'un polyéther-imide.

6. Fil conforme à la revendication 1, caractérisé en ce que la couche isolante constituée d'un film de résine synthétique comprend plusieurs couches faites d'au moins deux résines choisies dans le groupe constitué du poly(formal de vinyle), d'un polyester, d'un polyesterimide, d'un polyester-amide-imide, d'un polyamide-imide, d'un polyimide, d'une polyhydantoïne, d'un polyuréthane, d'un polyamide, d'une résine époxy, d'une résine acrylique et d'un polyéther-imide.

7. Fil conforme à la revendication 1, caractérisé en ce que la couche isolante en résine synthétique est formée selon un procédé choisi dans le groupe comprenant revêtement et cuisson de vernis, revêtement de poudre, revêtement par extrusion, et revêtement par électrodéposition d'une peinture isolante.