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(54) **Title**: CURABLE EPOXY COMPOSITION WITH MILLED GLASS FIBER

(57) **Abstract**: A curable epoxy composition for the production of an electrical insulation is provided. The curable epoxy composition comprises epoxy resin and harder, and a milled glass fiber.The epoxy resin is diglycidylether of bisphenol A, or diglycidylether of bisphenol F, or mixture of diglycidylether of bisphenol A and diglycidylether of bisphenol F, or cycloaliphatic epoxy resin, or hydrophobic cycloaliphatic epoxy resin; and and said hardener, preferably a phthalic acid anhydride or something similar. The milled glass fiber has a diameter of preferably 8-15 microns. The curable epoxy composition further comprises a filler and the filler is coated with a coating material. The present invention also provides a method for making shaped articles using a composition comprising the steps of preheating said curable epoxy composition; transferring said curable epoxy composition into a pre-heated mold, preferably under vacuum; and curing said epoxy composition at elevated temperature for a time to obtain a shaped articles with an infusion cross-linked structure.

CURABLE EPOXY COMPOSITION WITH MILLED GLASS FIBER

FIELD OF THE INVENTION

[0001] The present invention relates to an epoxy composition suitable for the production of electrical insulation systems with improved properties as well as to electrical articles comprising said electrical insulation system.

BACKGROUND OF THE INVENTION

[0002] Epoxy composition present many advantages compared to other thermosets and thermoplastics. Epoxy systems have a comparative low price, good processability, and after curing the cross-linked systems have good mechanical and electrical properties. Epoxy systems are widely used in the production of electrical insulation systems. Current commercially available epoxy systems which, after curing, yield electrical insulation systems generally comprise the following components: epoxy resin, hardener, catalyst and filler material.

[0003] The most popular filler material of epoxy systems for electrical applications is silica flour, and also other fillers such as aluminum oxide. It is quite important to improve the toughness of the current epoxy systems for electrical applications to manufacturers and users as there are lots of failures happened because of the cracking of epoxy insulation part after long time use or low temperature or thermal cycling or other factors. Certainly to improve the toughness is also a big challenge. The glass fiber has much higher length/diameter ratio compared to the spheral silica flour; with glass fiber, engineer can have epoxy resin compositions with much higher toughness while the higher length/diameter ratio also induced the sharply increasing of viscosity, which made the processing difficult even impossible. In addition, with lower content of glass fiber, the viscosity maybe can meet the processing requirement, while the thermal stability will be deteriorated obviously.

[0004] Therefore there is a need for improved epoxy systems with higher toughness, good processability and thermal stability.

SUMMARY OF THE INVENTION

[0005] To improve the toughness, processability and thermal stability of the epoxy systems, the present invention provides a curable epoxy composition with milled glass fiber.

[0006] According to one aspect of the invention, a curable epoxy composition with milled glass fiber used for the production of an electrical insulation is provided. The curable epoxy composition comprises epoxy resin and hardener, and further comprises a milled glass fiber.

[0007] According to a preferred embodiment of the present invention, the epoxy resin is diglycidylether of bisphenol A, or diglycidylether of bisphenol F, or mixture of diglycidylether of

bisphenol A and diglycidylether of bisphenol F, or cycloaliphatic epoxy resin, or hydrophobic cycloaliphatic epoxy resin; and the hardener comprises methyltetrahydrophthalic anhydride.

[0008] According to a preferred embodiment of the present invention, the milled glass fiber is within the range of 10% to 80% by weight, preferably within the range of 30% to 75% by weight, preferably within the range of 45% to 70% by weight, preferably within the range of 45% to 60% by weight, and preferably at 55% by weight. The milled glass fiber has a diameter of 5 microns to 20 microns, and preferably has a diameter of 8 microns, 9 microns, 10 microns, 11 microns, 12 microns, 13 microns, 14 microns, or 15 microns. And the milled glass fiber has an average length within the range of 30 microns up to 800 microns, preferably within the range of 40 microns to 500 microns, preferably within the range of 50 microns to 300 microns, preferably within the range of 60 microns to 150 microns, preferably within the range of 60 microns to 120 microns, and preferably at 90 microns.

[0009] According to a preferred embodiment of the present invention, the curable epoxy composition further comprises a filler.

[0010] According to the preferred embodiment, the filler is selected from the following filler materials or the compound of at least two of them: inorganic oxide, inorganic hydroxides, inorganic oxyhydroxides, quartz, known silicates, alumina oxide, aluminum trihydrate, titanium oxide or dolomite, metal nitrides, boron nitride, aluminum nitride or metal carbides. The weight ratio of milled glass fiber and the fillers in the mixture is within the ratio of 99:1 to 1:99, preferably within the range of 9:1 to 1:9, preferably within the range of 4:1 to 1:4, preferably within the range of 2:1 to 1:2, and preferably at the range of 1:1.

[0011] According to a preferred embodiment of the present invention, the curable epoxy composition further comprises a curing agent for enhancing its polymerization.

[0012] According to the preferred embodiment, the curing agent is the tertiary amines, the amine-complexes, the urea derivatives or the substituted imidazones. And the amout of said curing agent is less than 5% by weight, preferably within 0.01% to 2.5% by weight, preferably within 0.05% to 2% by weight, preferably within 0.05% to 1% by weight.

[0013] According to a preferred embodiment of the present invention, the curable epoxy composition further comprises a hydrophobic compound selected from the group comprising flowable fluorinated or chlorinated hydrocarbons which comprising -CH2-units, -CF2- units, -CF3-units, -CHCl-units, -C(Cl)2-units, -C(Cl)3-units, or the mixtures thereof; or a cyclic, linear or branched flowable organopolysiloxane.

[0014] According to the other aspect of the present invention, a method for producing a curable epoxy composition is provided. The method comprises the step of mixing the components of the epoxy resin, the hardener and a milled glass fiber.

[0015] According to a preferred embodiment, the method further comprises a step of mixing the component of a filler. Wherein, the milled glass fiber and the filler are separately added and mixed with the epoxy resin component under vacuum.

[0016] According to another aspect of the present invention, a method for making shaped

articles using a curable epoxy composition is provided. The method comprises the following steps: preheating a curable epoxy composition of any one of the above; transferring said epoxy composition into a pre-heated mold, preferably under vacuum; curing said epoxy composition to obtain shaped articles with an infusion cros-slinked structure.

[0017] According to another aspect of the present invention, an electrical article comprising an electrical insulation composition is provided. The electrical article is used for at least one selected from the group comprising dry-type transformers, particularly vacuum cast dry distribution transformers, which within the resin structure contain electrical conductors; polemount transformers for outdoor insulation; instrument transformers for medium voltage; high voltage insulation for indoor use, like breakers or switchgear application; high voltage and medium voltage bushings; as long-rod, composite and cap-type insulators, and also for base insulators in the medium voltage sector, in the production of insulators associated with outdoor power switches, measuring transducers, leadthroughs, and overvoltage protectors, in switchgear constructions, in power switches, and electrical machines, as coating materials for transistors and other semiconductor elements and/or to impregnate electrical components.

DETAILED DESCRIPTION OF EMBODIMENTS

[0018] According to the present invention the curable epoxy composition is made by simply mixing all the components, i.e. the epoxy resin, the hardener, the milled glass fiber or mixture of milled glass fiber and other filler, and any further additive which optionally may be present, optionally under vacuum, in any desired sequence.

[0019] Diglycidylether of bisphenol A and diglycidylether of bisphenol F are known in the art and are also commercially available as epoxy resin component. Cycloaliphatic epoxy resin and hydrophobic cycloaliphatic epoxy resin are known in the art and are also commercially available as an epoxy resin component.

[0020] The hardener compromises methyltetrahydrophthalic anhydride. Methyltetra-hydrophthalic anhydride is commercially available and exists in different forms. Although the different forms are not critical for the application in the present invention, 4- methyl-1,2,3,6-tetrahydrophthalic anhydride and 4- methyl-3,4,5,6-tetrahydrophthalic anhydride are the preferred compounds to be used. Methyltetrahydrophthalic anhydride is often supplied commercially as a mixture containing methyltetrahydrophthalic anhydride isomers as the main component, together with other anhydrides, such as tetrahydrophthalic anhydride, methyl-hexahydrophthalic anhydride and/or phthalic anhydride. The expression “methyltetrahydrophthalic anhydride” as used herein includes such mixtures within its scope. Such mixtures may also be used within the scope of the present invention. The content of methyltetrahydrophthalic anhydride within such a mixture is preferably at least 50% by weight, is preferably at least 60% by weight, is preferably at least 70% by weight, preferably at least 80% by weight, is preferably at least 90% by weight, calculated to the total weight of the anhydride mixture.

[0021] The reactive groups of the hardener components on curing the epoxy composition

react with the epoxide groups of the epoxy system, i.e. the reactive group of methyltetrahydrophthalic anhydride and the optionally present other anhydrides as mentioned above.

[0022] The optional hardener is preferably used in concentrations within the range of 0.8 to 1.2, preferably within the range of 0.9 to 1.1, equivalents of hardening groups present, e.g. one anhydride group per 1 epoxy equivalent.

[0023] The filler material comprises pure milled glass fiber or mixture of milled glass fiber with other fillers.

[0024] The pure milled glass fiber is present in the epoxy system, depending on the final application of the epoxy system, preferably within the range of about 10% by weight to about 80% by weight, preferably within the range of about 30% by weight to 75% by weight, preferably within the range of about 45% to about 70% by weight, preferably within the range of about 45% by weight to 60% by weight, and preferably at about 55% by weight, calculated to the total weight of the epoxy system.

[0025] The pure milled glass fiber has the diameter of 5 micron to 20 micron as know for the used in glass fiber reinforced polymer composites, preferably with the large scaled used commercial glass fiber with diameter of 8 microns, 9 microns, 10 microns, 11 microns, 12 microns, 13 microns, 14 microns, and 15 microns.

[0026] The pure milled glass fiber has an average length within the range of 30 microns up to 800 microns, preferably within the range of 40 microns to 500 microns, preferably within the range of 50 microns to 300 microns, preferably the range of 60 microns to 150 microns, preferably in the range of 60 microns to 120 microns, and preferably at about 90 microns.

[0027] The other filler is preferably selected from conventional flier materials as are generally used as fillers in electrical insulation. Preferably said filler is selected from the group of filler material comprising mineral, i.e. inorganic oxide, inorganic hydroxides and inorganic oxyhydroxides, preferably silica, quartz, known silicates, alumina oxide, aluminum trihydrate, titanium oxide or dolomite, metal nitrides, such as silicon nitride, boron nitride and aluminum nitride or metal carbides, such as silicon carbide. Preferred are silica and quartz, specifically silica flour, with an average grain size within the range as given above.

[0028] The mixture of milled glass fiber and other fillers is presented in the epoxy composition depending on the final application of the epoxy system, preferably within the range of about 20% by weight to about 80% by weight, preferably within the range of about 50% by weight to 70% by weight, preferably within the range of about 55% to about 65% by weight, and preferably at about 60% by weight, calculated to the total weight of the epoxy system.

[0029] The weight ratio of milled glass fiber and other fillers in the mixture is within the ratio of about 99:1 to 1:99, preferably within the range of about 9:1 to 1:9, preferably within the range of about 4:1 to 1:4, preferably within the range of 2:1 to 1:2, preferably within the range of 1:1.

[0030] The other filler in the mixture of milled glass fiber and other fillers has an average grain size as known for the use in electrical insulation systems and is generally with the range of 10

microns to 3mm. preferably is an average grain size within the range of 1 microns to 300 microns, preferably from 5 microns to 100 microns, or a selective mixture of such average grain sizes. Preferred also is a filler material with a high surface area.

[0031] The filler material may optionally be coated for example with a silane or a siloxane known for coating filler material, e.g. dimethylsiloxanes which may be cross linked, 3-Glycidoxypropyltrimethoxysilane, and 3-Aminopropyl-triethoxysilane or other known coating material.

[0032] As optional additives the epoxy composition may further comprise a curing agent (catalyst) for enhancing the polymerization of the epoxy resin with the hardener. Further additives may be selected from hydrophobic compounds including silicone, wetting/dispersing agent, plasticizers, antioxidants, light absorbers, pigments, flame retardants, and other additives generally used in electrical application.

[0033] Preferred curing agents (catalyst) are for example tertiary amines, such as benzyldimethylamine or amine-complexes such as complexes of tertiary amines with boron trichloride or boron trifluride; urea derivatives, such as N-4-chlorophenyl-N',N'-dimethylurea; optionally substituted imidazones such as imidazole or 2-phenyl-imidazole. Preferred are tertiary amines, especially 1-substituted imidazole and/or N,N-dimethylbenzylamine, such as 1-alkyl imidazoles which may or may not be substituted also in the 2-position, such as 1-methyl imidazole or 1-isopropyl-2-methyl imidazole. Preferred is 1-methyl imidazole. The amount of catalyst used in a concentration of less than 5% by weight, preferably about 0.01% to 2.5%, preferably about 0.05% to 2% by weight, preferably about 0.05% to 1% by weight, calculated to the weight of the epoxide present within the epoxy system.

[0034] According to the preferred embodiment of the present invention, the curable epoxy composition further comprises a suitable hydrophobic compound or a mixture of such compounds, especially for improving the self healing properties of the electrical insulator may be selected from the group comprising flowable fluorinated or chlorinated hydrocarbons which contain-CH_2-units, -CF_2-units, -CF_3-units, -CHCl-units, -$C(Cl)_2$-units, -$C(Cl)_3$-units, or mixtures thereof; or a cyclic, linear or branched flowable organopolysiloxane.

[0035] The hydrophobic compound is added to the epoxy composition preferably in an amount of from 0.1% to 10%, preferably in an amount of from 0.25% to 5% by weight, preferably in an amount of from 0.25% to 3% by weight, calculated to the weight of the weight of epoxide present.

[0036] The present invention further refers to a method of producing said curable epoxy system. According to the present invention the curable epoxy composition is made by simply mixing all the components, i.e. the epoxy resin, the hardener, the milled glass fiber or mixture of milled glass fiber and other filler, and any further additive which optionally may be present, optionally under vacuum, in any desired sequence.

[0037] Preferably the hardener, the milled glass fiber or mixture of milled glass fiber and other filler, and any further additives, are separately added and intensively mixed with the epoxy resin

component to finally yield the uncured epoxy system, preferably under vacuum.

[0038] The uncured epoxy composition is cured, at a temperature within the range of 40°C to 250°C, preferably within the range of 80°C to 180°C, preferably within the range of 100°C to 160°C, and preferably at about 140°C and during a curing time within the range of about 2 hours to 20 hours, preferably within the range of 2 hours to 8 hours. Curing generally is possible also at lower temperature, whereby at lower temperature complete curing may last up to several days depending on the catalyst present and its concentration.

[0039] Suitable process for fabrication the cured epoxy composition of the invention is for example the vacuum casting process and the automated pressure gelation process. Such processes typically include a curing step in the mold for a time sufficient to shape the epoxy composition into its final infusible three dimensional structure, typically up to 10 hours, and as post-curing step of the demolded article at elevated temperature to develop the ultimate physical and mechanical properties of the cured epoxy system. Such a post-curing step may take, depending on the shape and size of the article, up to 30 hours.

[0040] In the proffered embodiment of the present, a method for making shaped articles using a composition is provided. It comprises the steps of

1) Preheating a curable epoxy composition comprising epoxy resin described above, hardener described above, milled glass fiber or mixture of milled glass fiber and other filler described above, and optionally further additives;

2) Transferring said epoxy composition into a pre-heated mold, preferably under vacuum;

3) Curing said epoxy composition at elevated temperature for a time to obtain a shaped articles with an infusion cross-linked structure; and

4) Optionally post curing the obtained shaped article.

[0041] Preferred uses of the insulation systems produced according to the present invention are dry-type transformers, particularly cast coils for dry type distribution transformers, especially vacuum cast dry distribution transformers, which within the resin structure contain electrical conductors; polemount transformers for outdoor insulation; instrument transformers for medium voltage; high voltage insulation for indoor use, like breakers or switchgear application; high voltage and medium voltage bushings; as long-rod, composite and cap-type insulators, and also for base insulators in the medium voltage sector, in the production of insulators associated with outdoor power switches, measuring transducers, leadthroughs, and overvoltage protectors, in switchgear constructions, in power switches, and electrical machines, as coating materials for transistors and other semiconductor elements and/or to impregnate electrical components.

[0042] The present invention further refers to the electrical articles containing an electrical insulation system according to the present invention.

[0043] The following examples illustrate the invention without limiting the scope of the claimed invention. Suppliers are named for different components, whereby of course the invention is not bound to the compounds supplied by the named suppliers.

[0044] Examples 1-5 and comparative example

General procedure

The silica flour was dried overnight at 120℃-160℃ and cooled down to 50℃ -70℃. the epoxy resin and the hardener were preheated separately to 40℃ -75 ℃, the mixing of all components was carried out for 20-30 minutes in small aluminum buckets or beakers with an overhead stirrer. Degassing was performed at 40℃ -75℃ and 1 mbar before and after casting. Plates were cast and cured at 140℃.

[0045] Preparation of the comparative example A

A commercial system consisting of a diglycidylether of bisphenol A and diglycidylether of bisphenol F mixture supplied by Hexion under the commercial name Epikote EPR 845, a pre-reacted hardener supplied by Hexion under the commercial name Epikure EPH 05389 and silica flour Millisil W12 supplied by Quarzwerke were intensively mixed together under the conditions as described above and degassed before and after casting. Plates were cast and cured at 140℃. Quantities were used as given in Table 1.

	Epoxy resin	hardener	Filler, silica flour
Parts by weight	100	84	335

Table 1 (composition of the comparative example A)

[0046] Epoxy resin: Epikote EPR 845 (Hexion)

Hardener: Epikure EPH 05389 (Hexion)

Filler: Millisil W12 (Quarzwerke)

[0047] Preparation of the examples 1-5

Step 1: Epoxy resin (mixture of diglycidylether of bisphenol A and diglycidylether of bisphenol F) and part of milled glass fiber or mixture of milled glass fiber and silica flour were intensively mixed in a vessel under vacuum at a temperature of 65°C;

Step 2: Hardener with the rest of milled glass fiber or mixture of milled glass fiber and silica flour were intensively mixed in a vessel under vacuum at a temperature of about 65℃ ;

Step 3: the material obtained from step 1 and step 2were mixed with a mixer and further degassed. Plates were cast under vacuum and cured at 140℃. quantities were used as given in table 2.

	Example 1	Example 2	Example 3	Example 4	Examples 5
Epoxy resin	100	100	100	100	100
Hardener	84	84	84	84	84
Filler: Milled glass fiber +	185 +	226 +	278 +	113 +	93 +

Silica flour	0	0	0	113	185

Table 2 (composition of examples 1-5, given in parts by weight)

[0048] Epoxy resin: Epikote EPR 845 (Hexion)

Hardener: Epikure EPH 05389 (Hexion)

Milled glass fiber: ECPTQ (Hangzhou Gaoke)

Silica flour: Millisil W12 (Quarzwerke)

[0049] Preparation of the comparative example B

[0050] A commercial system consisting of a hydrophobic cycloaliphatic epoxy resin by Huntsman under the commercial name Araldite CY 5622, a hardener supplied by Huntsman under the commercial name Aradur HY 1235, the catalyst DY 062 supplied by Huntsman and Silanized silica flour Silbond W12 EST supplied by Quarzwerke were intensively mixed together under the conditions as described above in general procedure and degassed before and after casting. Plates were cast and cured at 140℃. quantities were used as given in Table 3.

	Epoxy resin	hardener	catalyst	Filler, silica flour
Parts by weight	100	82	0.5	325

Table 3 (composition of the comparative example B)

[0051] Epoxy resin: Araldite CY 5622 (Huntsman)

Hardener: Aradur HY 1235 (Huntsman)

Catalyst: DY 062 (Huntsman)

Filler: Silbond W12 EST (Quarzwerke)

[0052] Preparation of the examples 6-10

Step A: Epoxy resin (modified cycloaliphatic epoxy resin) and part of milled glass fiber or mixture of milled glass fiber and silica flour were intensively mixed in a vessel under vacuum at a temperature of 60℃;

Step B: Hardener with the rest of milled glass fiber or mixture of milled glass fiber and silica flour and catalyst DY062 were intensively mixed in a vessel under vacuum at a temperature of about 60℃;

Step C: the material obtained from step A and step B were mixed with a mixer and further degassed. Plates were cast under vacuum and cured at 140℃. Quantities were used as given in table 4

	Example 6	Example 7	Example 8	Example 9	Examples 10
Epoxy resin	100	100	100	100	100
Hardener	82	82	82	82	82
Filler: Milled glass fiber + Silica flour	183 + 0	223 + 0	274 + 0	111 + 111	91 + 182

Catalyst	0.5	0.5	0.5	0.5	0.5

Table 4 (composition of examples 6-10, given in parts by weight)

[0053] Epoxy resin: Araldite CY 5622 (Huntsman)

Hardener: Aradur HY 1235 (Huntsman)

Catalyst: DY 062 (Huntsman)

Milled glass fiber: ECPTQ (Hangzhou Gaoke)

Filler: Silbond W12 EST (Quarzwerke)

[0054] Though the present invention has been described on the basis of some preferred embodiments, those skilled in the art should appreciate that those embodiments should by no means limit the scope of the present invention. There are many variations and modifications to the embodiments. Without departing from the spirit and concept of the present invention, any variations and modifications to the embodiments should be within the apprehension of those with ordinary knowledge and skills in the art, and therefore fall in the scope of the present invention which is defined by the accompanied claims.

CLAIMS

1. A curable epoxy composition for the production of an electrical insulation comprising epoxy resin and harder, wherein, it further comprising a milled glass fiber.

2. A curable epoxy composition according to Claim 1, wherein, said epoxy resin is diglycidylether of bisphenol A, or diglycidylether of bisphenol F, or mixture of diglycidylether of bisphenol A and diglycidylether of bisphenol F, or cycloaliphatic epoxy resin, or hydrophobic cycloaliphatic epoxy resin; and said hardener, preferably a phthalic acid anhydride or something similar.

3. A curable epoxy composition according to Claim 1 or 2, wherein, the milled glass fiber is within the range of 10% to 80% by weight, preferably within the range of 30% to 75% by weight, preferably within the range of 45% to 70% by weight, preferably within the range of 45% to 60% by weight, and preferably at 55% by weight.

4. A curable epoxy composition according to Claim 1 or 2, wherein, the milled glass fiber has a diameter of 5 microns to 20 microns, and preferably has a diameter of 8 microns, 9 microns, 10 microns, 11 microns, 12 microns, 13 microns, 14 microns, or 15 microns.

5. A curable epoxy composition according to Claim 1 or 2, wherein, the milled glass fiber has an average length within the range of 30 microns up to 800 microns, preferably within the range of 40 microns to 500 microns, preferably within the range of 50 microns to 300 microns, preferably within the range of 60 microns to 150 microns, preferably within the range of 60 microns to 120 microns, and preferably at 90 microns.

6. A curable epoxy composition according to Claim 1 or 2, wherein, it further comprises a filler.

7. A curable epoxy composition according to Claim 6, wherein, said filler is selected from the following filler materials or the compound of at least two of them: inorganic oxide, inorganic hydroxides, inorganic oxyhydroxides, quartz, known silicates, alumina oxide, aluminum trihydrate, titanium oxide or dolomite, metal nitrides, boron nitride, aluminum nitride or metal carbides. Preferred are silica and quartz, specifically silica flour

8. A curable epoxy composition according to Claim 6, wherein, the weight ratio of milled glass fiber and the fillers in the mixture is within the ratio of 99:1 to 1:99, preferably within the range of 9:1 to 1:9, preferably within the range of 4:1 to 1:4, preferably within the range of 2:1 to 1:2, and preferably at the range of 1:1.

9. A curable epoxy composition according to Claim 6, wherein, said filler is coated with a coating material.

10. A curable epoxy composition according to Claim 1 or 2, wherein, it further comprises at least one additive selected from curing agents, hydrophobic compound, wetting/dispersing agents, plasticizers, antioxidants, light absorbers, pigments, flame retardants and fibers.

11. The use of a curable epoxy resin composition according to anyone of claims 1-10 for the production of insulation composition in electrical articles.

12. A method for producing a curable epoxy composition for the production of an electrical insulation composition comprising the step of mixing the components of the epoxy resin, the hardener and a milled glass fiber.

13. A method for producing a curable epoxy composition for the production of an electrical insulation composition, wherein, the uncured epoxy resin composition is cured, preferably under application of vacuum, at a temperature preferably within the range of 40℃ to 250℃, preferably within the range of 80℃ to 180℃, preferably within the range of 100℃ to 160℃, and preferably at 140℃; and during a curing time within the range of 2 hours to 20 hours, preferably within the range of 2 hours to 8 hours.

14. A method for making shaped articles using a composition according to anyone of claim 1-10, comprising the steps of

preheating said curable epoxy composition;

transferring said curable epoxy composition into a pre-heated mold, preferably under vacuum; and

curing said epoxy composition at elevated temperature for a time to obtain a shaped articles with an infusion cross-linked structure.

15. An electrical article comprising an electrical insulation composition according to any one of claim 1-10 used for at least one selected from the group comprising dry-type transformers, particularly vacuum cast dry distribution transformers, which within the resin structure contain electrical conductors; polemount transformers for outdoor insulation; instrument transformers for medium voltage; high voltage insulation for indoor use, like breakers or switchgear application; high voltage and medium voltage bushings; as long-rod, composite and cap-type insulators, and also for base insulators in the medium voltage sector, in the production of insulators associated with outdoor power switches, measuring transducers, leadthroughs, and overvoltage protectors, in switchgear constructions, in power switches, and electrical machines, as coating materials for transistors and other semiconductor elements and/or to impregnate electrical components.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C08L63/-; C08K7/14; H01F27/-; B29C45/-

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, WPI, EPODOC, CNKI; epoxy, epoxide, +glycidyl, glass, fiber, fibre, milled, powder

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN101343399A (UNIV CENT SOUTH) 14 January 2009 (14.01.2009) page 1, line 22 to page 4, line 16	1-15
X	CN101343400A (UNIV CENT SOUTH) 14 January 2009 (14.01.2009) claims 1-12	1-15
X	LI Zhihua; XIE Keyu; ZHENG Ziqiao. Morphology and mechanical properties of MG/PU/EP encapsulating composite, School of Materials Science and Engineering, 2007, Vol.38, No.1, Pages 51-55	1-15
A	JP3131057A (NITTO DENKO CORP) 04 June 1991 (04.06.1991) the whole document	1-15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 November 2012 (19.11.2012)	**29 Nov. 2012 (29.11.2012)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer LI, Kaiyang Telephone No. (86-10)62084429

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/071455

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN101343399A	14.01.2009	CN101343399B	12.10.2011
CN101343400A	14.01.2009	NONE	
JP3131057A	04.06.1991	NONE	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/071455

CLASSIFICATION OF SUBJECT MATTER:

C08K 7/14 (2006.01) i

C08L 63/00 (2006.01) i

B29C 45/02 (2006.01) i

H01F 27/00 (2006.01) i