Title: EPOXY MOLDING COMPOUND, ITS MANUFACTURING PROCESS AND USE, AND TRANSISTOR OUTLINE PRODUCT CONTAINING MOLDED PRODUCT THEREOF

Abstract: An epoxy molding compound is provided, the compound comprises (a) 2 to 15wt. % of an epoxy resin; (b) 2 to 15wt. % of a phenolic resin; (c) 60 to 90 wt. % of a filler; (d) 0.1 to 0.6wt. % of a catalyst; (e) 0.1 to 3 wt. % of a releasing agent; (f) 0.1 to 1 wt. % of a pigment; (g) 0.05 to 3 wt. % of a silane; (h) 0 to 3 wt. % of an ion trapping agent; (i) 0 to 15 wt. % of a flame retardant; and (j) 0 to 2wt. % of a stress modifier; wherein the weight percentages are based on the total weight of the epoxy molding compound. By using specific components and their specific amounts, the molded products produced from the epoxy molding compounds can be used in high current applications, especially in high current TO products.
EPOXY MOLDING COMPOUND, ITS MANUFACTURING PROCESS AND USE, AND TRANSISTOR OUTLINE PACKAGE PRODUCT CONTAINING MOLDED PRODUCT THEREOF

Technical Field
The present invention relates to an epoxy molding compound, a manufacturing process and use of the epoxy molding compound, and a TO product containing a molded product produced from the epoxy molding compound.

Background Art
Molded epoxy resin products are widely used as component parts in electrical and electronic devices, such as transistors and integrated circuit boards, because epoxy resin has well balanced properties including molding property, electrical property, moisture resistance, heat resistance, mechanical property and adhesion to component inserted therein, etc.

Molded epoxy resin products are produced from epoxy molding compounds. A typical epoxy molding compound comprises an epoxy resin, a curing agent (hardener), a curing accelerator (catalyst), and optionally fillers and additives. An epoxy molding compound can be molded and cured to a solid shaped article in a mold at elevated temperature and for a certain time.

For most general applications, TO (transistor outline package), such as TO92, TO 263 and TO3P, is used with current of several amperes or less. However, with the development of technology of the semiconductor device, chips in transistor outline semiconductor package, such as TO220 and TO252, will be generally subjected to current of hundreds of amperes (about 200 A), especially for terminal applications of electromobile, automobile, and other fields. Existing epoxy molding compounds can be hardly used in high current (>200 A) TO products, because of the risk of electric leakage caused by heat accumulation and ancillary unmatched material deformation.

Thus, there is a demand of designing an epoxy molding compound to use for high current electronic or electronic device, especially for high current TO product, with high reliability.

Summary of the Invention
Accordingly, the object of the present invention is to provide an epoxy molding compound, which can be used in a high current electrical or electronic device, especially in a high current TO product, with high reliability.

In one aspect, the present invention provides an epoxy molding compound, comprising

(a) 2 to 15 wt.% of an epoxy resin;
(b) 2 to 15 wt.% of a phenolic resin;
(c) 60 to 90 wt.% of a filler;
(d) 0.1 to 0.6 wt.% of a catalyst;
(e) 0.1 to 3 wt.% of a releasing agent;
(f) 0.1 to 1 wt.% of a pigment;
(g) 0.05 to 3 wt.% of a silane;
(h) 0 to 3 wt.% of an ion trapping agent;
(i) 0 to 15 wt.% of a flame retardant; and
(j) 0 to 2 wt.% of a stress modifier;

wherein the weight percentages are based on the total weight of the epoxy molding compound.

In another aspect the present invention provides a process for manufacturing the epoxy molding compound of the present invention, comprising steps of:

(1) weighing up components (b), (e) and a part of component (c), and mixing them by a ball mill to get a premixed mixture;
(2) mixing the premixed mixture with all the remaining components in a high speed blender to obtain a mixture;
(3) putting the mixture into an extruder to extrude it and kneading the same at 90 to 120°C; and
(4) cooling the material obtained from step (3) down, and crushing into powder.

Yet in another aspect, the present invention provides the use of the epoxy molding compound of the present invention as transistor material, such as diode material and audion material; printed circuit board material, electronic circuit board material, adhesives, interlayer insulating materials, etc.

Yet in another aspect, the present invention provides a TO (transistor outline package) product containing a molded product produced from the epoxy molding compound of the present invention.
According to the present invention, by using specific components and their specific amounts, the molded products produced from the epoxy molding compounds can be used in high current applications, especially in high current TO products.

**Detailed description**

In the following passages the present invention is described in more detail. Each aspect so described may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

In the context of the present invention, the terms used are to be construed in accordance with the following definitions, unless a context dictates otherwise. As used herein, the singular forms "a", "an" and "the" include both singular and plural referents unless the context clearly dictates otherwise.

The terms "comprising", "comprises" and "comprised of" as used herein are synonymous with "including", "includes" or "containing", "contains", and are inclusive or open-ended and do not exclude additional, non-recited members, elements or method steps.

The recitation of numerical end points includes all numbers and fractions subsumed within the respective ranges, as well as the recited end points. When an amount, a concentration or other values or parameters is/are expressed in form of a range, a preferable range, or a preferable upper limit value and a preferable lower limit value, it should be understood as that any ranges obtained by combining any upper limit or preferable value with any lower limit or preferable value are specifically disclosed, without considering whether the obtained ranges are clearly mentioned in the context.

Unless otherwise defined, all terms used in the disclosure of the invention, including technical and scientific terms, have the meaning as commonly understood by one of the ordinary skill in the art to which this invention belongs to. By means of further guidance, term definitions are included to better appreciate the teaching of the present invention.
The present invention provides an epoxy molding compound, comprising
(a) 2 to 15 wt.% of an epoxy resin;
(b) 2 to 15 wt.% of a phenolic resin;
(c) 60 to 90 wt.% of a filler;
(d) 0.1 to 0.6 wt.% of a catalyst;
(e) 0.1 to 3 wt.% of a releasing agent;
(f) 0.1 to 1 wt.% of a pigment;
(g) 0.05 to 3 wt.% of a silane;
(h) 0 to 3 wt.% of an ion trapping agent;
(i) 0 to 15 wt.% of a flame retardant; and
(j) 0 to 2 wt.% of a stress modifier;
wherein the weight percentages are based on the total weight of the epoxy molding compound.

**Epoxy resin (a)**
As used herein, the term "epoxy resin" means a polymer containing generally two or more epoxide groups per molecule.

As the epoxy resin (a) used in the epoxy molding compound of the present invention, any epoxy resins commonly used are suitable. There are no particular limitations. Examples thereof include but not limited to bisphenol epoxy resins such as bisphenol A epoxy resins, bisphenol F epoxy resins, bisphenol S epoxy resins, and the like; biphenyl epoxy resins such as biphenyl epoxy resins, tetramethylbiphenyl epoxy resins, and the like; novolac epoxy resins such as phenol novolac epoxy resins, cresol novolac epoxy resins, bisphenol A novolac epoxy resins, epoxy compounds of condensates of phenols and phenolic hydroxyl group-containing aromatic aldehyde, biphenyl novolac epoxy resins, and the like; triphenylmethane epoxy resins; tetraphenylethane epoxy resins; dicyclopentadiene phenol addition reaction-type epoxy resins; phenolaralkyl epoxy resins; epoxy resins each having a naphthalene skeleton in its molecular structure, such as napththal novolac epoxy resins, napththolaralkyl epoxy resins, and the like; brominated bisphenol epoxy resins, alicyclic epoxy resins, and glycidyl ether epoxy resins. These epoxy resins may be used alone or as a mixture of two or more.

Among the above-described epoxy resins, epoxy o-cresol novolac resin (EOCN), dicyclopentadiene epoxy resin (DCPD), biphenyl epoxy resin and multi-aromatic epoxy resin (MAR) are preferred.
The amount of the epoxy resin (a) in the epoxy molding compound is preferably 5-13 wt.%, more preferably 9-11 wt.% based on the total weight of the epoxy molding compound.

**Phenolic resin (b)**

As used herein, the term "phenolic resin" means a polymer containing two or more hydroxyl groups per molecule.

The phenolic resin (b) used as a curing agent in the epoxy molding compound of the present invention is selected from the group consisting of phenolic novolac resin (PN), cresol novolac resin, phenol aralkyl novolac resin, multi-aromatic novolac resin, multi-functional novolac resin, and mixtures thereof.

Among the above-described phenolic resins, phenolic novolac resin is preferred.

As phenolic resin (b), one or more of the above-mentioned phenolic resins may be used, and any other conventionally known curing agent may be also used in combination.

The amount of the phenolic resin (b) in the epoxy molding compound is preferably 5-13 wt.%, more preferably 7-11 wt.% based on the total weight of the epoxy molding compound.

The mole ratio of epoxy groups in the epoxy resin to hydroxyl groups in the phenolic resin is preferably from 0.5 to 1.5, more preferably from 0.5 to 1.2.

**Filler (c)**

A wide range of fillers may be used in the epoxy molding compound of the present invention to improve certain properties of the molded product, such as abrasion resistance, moisture resistance, thermal conductivity or electrical properties.

As filler (c) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of crystalline silica,
fused silica, spherical silica, titanium oxide, aluminium hydroxide, magnesium hydroxide, zirconium dioxide, calcium carbonate, calcium silicate, talc, clay, carbon fiber, and glass fiber.

Among the above-described fillers, fused silica, spherical silica and crystalline silica are preferred.

As filler (c), one or more of the above-mentioned fillers may be used, and any other conventionally known filler may be also used in combination.

The amount of filler (c) in the epoxy molding compound is preferably 65-80 wt.%, more preferably 68-73 wt.% based on the total weight of the epoxy molding compound.

**Catalyst (d)**

As used herein, the term "catalyst" means substance which catalyzes or accelerates the curing reaction between the epoxy resin and the phenolic resin.

As catalyst (d) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of amine compound, organic phosphorus compounds, tetraphenyl phosphine compound and imidazole type compounds.

Among the above-described catalysts, triphenyl phosphine catalyst, 1,8-dizzabicyclo(5,4,0) undecene-7 catalyst and imidazole catalyst are preferred.

Among the above-described catalysts, triphenyl phosphine (TPP), 1,8-dizzabicyclo(5,4,0) undecene-7(DBU), 2,4-diamo-6[2'-methylimidazolyl-(1 ')]ethyl-s-triazine (2MZ), and 2-phenyl-4-methyl imidazole (2P4MZ) are more preferred.

As catalyst (d), one or more of the above-mentioned catalysts may be used.

The amount of catalyst (d) in the epoxy molding compound is preferably 0.2-0.5 wt.%, more preferably 0.3-0.4 wt.% based on the total weight of the epoxy molding compound.
Releasing agent (e)
As releasing agent (e) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of natural waxes and synthetic waxes. Examples thereof include, but not limited to, montan waxes, fatty acid ester type waxes, fatty acid type waxes, aliphatic ester type waxes, polyethylene type waxes, polypropylene type waxes, alkyl oligomer type waxes, and amide type waxes.

Among the above-described releasing agents, polyethylene type waxes, fatty acid type waxes, and fatty acid type waxes are preferred.

As releasing agent (e), one or more of the above-mentioned waxes may be used.

The amount of releasing agent (e) in the epoxy molding compound is preferably 0.1-2 wt.%, more preferably 0.3-1 wt.% based on the total weight of the epoxy molding compound.

Pigment (f), Silane (g), Ion trapping agent (h), Flame retardant (i) and Stress modifier (i)
As pigment (f) used in the epoxy molding compound of the present invention, it can be carbon black, and its amount is preferably 0.1-0.8 wt.%, more preferably 0.2-0.5 wt.% based on the total weight of the epoxy molding compound.

As silane (g) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of epoxy-containing silanes, methylpropenyl-containing silanes, amino-containing silanes and mercapto-containing silanes; and its amount is preferably 0.05-2 wt.%, more preferably 0.2-1 wt.% based on the total weight of the epoxy molding compound.

As ion trapping agent (h) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of hydrotalcite, hydroxide or oxide of magnesium, zirconium, aluminum, bismuth, antimony, and titanium; and its amount is preferably 0.1-2.5 wt.%, more preferably 0.2-0.9 wt.% based on the total weight of the epoxy molding compound.
As flame retardant (i) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of brominated epoxy flame retardants, antimony oxide, organic phosphorus compounds, melamine type flame retardants, aluminum hydroxide, magnesium hydroxide, zinc borate and titanium oxide; and its amount is preferably 1-12 wt.%, more preferably 8-10 wt.% based on the total weight of the epoxy molding compound.

As stress modifier (j) used in the epoxy molding compound of the present invention, it can be one or more selected from the group consisting of epoxy group substituted silicone resin, amino group substituted silicone resin, epoxy and polyether substituted silicon resin, oxidized polybutadiene rubber and silicon oxide rubber with core-shell structure; and its amount is preferably 1-1.9 wt.%, more preferably 1.2-1.5 wt.% based on the total weight of the epoxy molding compound.

In a preferred embodiment of the present invention, an epoxy molding compound comprises:
(a) 5-13 wt.% of an epoxy resin;
(b) 5-13 wt.% of a phenolic resin;
(c) 65-80 wt.% of a filler;
(d) 0.2-0.5 wt.% of a catalyst;
(e) 0.1-2 wt.% of a releasing agent;
(f) 0.1-0.8 wt.% of a pigment;
(g) 0.05-2 wt.% of a silane;
(h) 0.1-2.5 wt.% of an ion trapping agent;
(i) 1-12 wt.% of a flame retardant; and
(j) 1-1.9 wt.% of a stress modifier;

wherein the weight percentages are based on the total weight of the epoxy molding compound.

In a further preferred embodiment of the present invention, an epoxy molding compound comprises:
(a) 9-11 wt.% of an epoxy resin;
(b) 7-11 wt.% of a phenolic resin;
(c) 68-73 wt.% of a filler;
(d) 0.3-0.4 wt.% of a catalyst;
(e) 0.3-1 wt.% of a releasing agent;
(f) 0.2-0.5 wt.% of a pigment;
(g) 0.2-1 wt.% of a silane;
(h) 0.2-0.9 wt.% of an ion trapping agent;
(i) 8-10 wt.% of a flame retardant; and
(j) 1.2-1.5 wt.% of a stress modifier;

wherein the weight percentages are based on the total weight of the epoxy molding compound.

There is no special limit for the manufacturing method of the epoxy molding compound of the present invention. In a preferred embodiment, the epoxy molding compound is manufactured by a process comprising steps of:

(1) weighing up components (b), (e) and a part of component (c), and mixing them by a ball mill to get a premixed mixture;
(2) mixing the premixed mixture with all the remaining components in a high speed blender to obtain a mixture;
(3) putting the mixture into an extruder to extrude it and kneading the same at 90 to 120 °C; and
(4) cooling the material obtained from step (3) down, and crushing into powder.

The epoxy molding compound of the present invention can be used as transistor material, such as diode material and audion material; printed circuit board material, electronic circuit board material, adhesives, interlayer insulating materials, etc. By using specific components and their specific amounts, the molded products produced from the epoxy molding compounds can be used in high current applications, especially in high current TO products.

Accordingly, the present invention provides a TO (transistor outline package) product containing a molded product produced from the epoxy molding compound of the present invention.

**Examples**
The present invention will be illustrated in details by means of examples below. However, it is to be understood by one of ordinary skill in the art that this part is a description of exemplary embodiments only, and is not intended as limiting
the broader aspects of the present invention.

**Raw materials**

1): Dicyclopentadienefenol epoxy resin (DCPD),

2): O-cresol novolac epoxy resins (EOCN),

3): Multi aromatic epoxy resin (MAR),

4): Biphenyl epoxy resin (BP),

5): Phenol novolac resin (PN),

6): Triphenyl phosphine (TPP)

7): 2-phenyl-4-methyl imidazole (2P4MZ)

8): 1,8-dizabicyclo(5,4,0) undecene-7 (DBU)

9) Fused silica, (0.1 - 10 μm, Mean size 0.2-5 μm)

10): Spherical silica, (0.1 - 10 μm 15-45%, 10-75 μm 55-85%, Mean size 20-50 μm)

11): Crystalline silica, (0.1 - 10 pm, Mean size 0.2-5 pm)

12): Magnesium Aluminum hydroxide type ion trapping agent

13): Aluminum hydroxide flame retardant
14): Bromine-epoxy flame retardant
15): Antimony oxide flame retardant
16): Zinc borate flame retardant
17): Epoxysilane type coupling agent, (Epoxidized silicone glycidyl resin)
18): Aminosilane type coupling agent, (phenylamino propyltrimethoxysilane)
19): Mercaptolsilane type coupling agent, (3-Mercaptopropyltrimethoxysilane)
20): Polyethylene wax, ( )
21): Fatty acid ester wax, ( )
22): Carbon black
23): Polybutadiene-type stress absorbing agent

**Test methods**
The spiral flow, gel time, adhesion on Cu by tab pull test, volume resistivity, thermal conductivity, electrical conductivity, chloride ion content, failure on high current pulse, delamination on TO220 after IR, and HAST 96 h on TO220 of each of the epoxy molding compounds as well as the Tg and CTE1 &2 of the molded product thereof were tested with the following test methods, respectively.

**SPIRAL FLOW**
In the spiral flow test the flow property of the epoxy molding compound was determined by measuring the length and weight of the resin flowing along the path of a spiral cavity. Sample for the spiral flow test was the powder sample of the epoxy molding compound. No additional preparation was required. The spiral flow test was done according to the method EM1-1-66. Test conditions were set as follows: temperature 175 °C, pressure 70km/cm² and cure time 90s.

**GEL TIME**
In the gel time test the gelation point of the epoxy molding compound was tested. In the test, a hot plate was heated to the temperature of 175°C. The powder sample of the epoxy molding compound was placed on the hot plate and let it stand as long as the sample was gelled, with stopwatch gelling time was measured (stopwatch was started immediately when the sample is placed on the hot plate and stopped when gelling was complete).

GLASS TRANSITION TEMPERATURE Tg & COEFFICIENT OF THERMAL EXPANSION (CTE1 &2)
In the test, the Tg, CTE 1 and CTE2 of the molded product were tested. In the test, the sample from the extruder was made to be a sheet by a moulding machine at a moulding temperature of 180°C for 150s. After moulding, put the sheet into an oven at a temperature of 180°C for 6 hours. The sheet parameter is 5cm*1 cm*0.4cm. Tg of the sheet was measured using TMA (Thermo-mechanical analysis), where the sample was placed in the TMA machine, the heating rate was 10°C/min, the heating was carried out until 280 °C, the frequency was 5Hz and the Tg was the peak of tan δ figure.

In the test, the glass transition temperature was tested at 70 to 220 °C, the CTE 1 was tested at 50 to 70 °C, and the CTE 2 was tested at 220 to 240 °C.

ADHESION ON CU BY TAB PULL TEST
The adhesion on Cu by tab pull test value was determined using an electronic universal testing machine as follows: the epoxy molding compound was molded on a tabpull frame. After moulding, the sample piece was post-cured in an oven at 175°C for 6 hours, and then tested for the adhesion on Cu with the electronic universal testing machine.

THERMAL CONDUCTIVITY
The thermal conductivity value was determined using a thermal conductivity instrument Quickline-10 from ANTER Corporation as follows: after moulding, the sample piece was post-cured in an oven at 175°C for 6 hours, and then tested for the thermal conductivity with the thermal conductivity tester.

VOLUME CONDUCTIVITY
The volume conductivity value was determined using a volume conductivity tester as follows: after moulding, the sample piece was post-cured in an oven at 175°C for 6 hours, and then tested for the volume conductivity with the
volume conductivity tester.

**ELECTRICAL CONDUCTIVITY & CHLORIDE ION CONTENT**
The electrical conductivity value and chloride ion content were determined using ion chromatography as follows: the epoxy moulding compounds powder was extracted in boiling water for 20hrs, and then was tested for the electrical conductivity and chloride ion content with ion chromatograph.

**FAILURE ON HIGH CURRENT PULSE**
High current pulse test was conducted by giving a 200 A current pulse on the package molded by the epoxy molding compound samples. The above process was repeated for 10 times and the failure ratio was counted.

**DELAMINATION ON TO220 AFTER IR**
Delamination performance was tested by the following protocol. The TO220 packages molded from epoxy molding compound samples were put in a constant temperature oven at 175 °C for 6h, then dealtered with IR reflow for 3 times and observed by an ultrasonic scanner.

**HAST 96H**
HAST experiment was determined by the failure ratio of the package molded by epoxy molding compound samples in the environment of 85 °C and 85 RH% for 96h.
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<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
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<tr>
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<td>0.35%</td>
<td>0.35%</td>
<td>0.35%</td>
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**Table 1 (continued)**

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<th>Example 8</th>
<th>Example 9</th>
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<th>Example 12</th>
<th>Example 13</th>
<th>Comparative example 1</th>
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<td>Epoxy o-cresol novolac resin</td>
<td>4%</td>
<td>4%</td>
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<td>7%</td>
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<td>9%</td>
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<td>0.1%</td>
<td>0.1%</td>
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<td>25%</td>
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<td>Crystalline silica</td>
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<td>Aluminum hydroxide flame retardant</td>
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<td></td>
<td></td>
<td>8%</td>
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<td>Bromine-epoxy flame retardant</td>
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<td>Antimony oxide</td>
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<td>Zinc borate flame retardant</td>
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<td>10%</td>
<td>10%</td>
<td>8%</td>
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<td>0.2%</td>
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<td>0.15%</td>
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<td>Amino group contained and silane coupling agent</td>
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<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
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<td>Mercapto group propyl contained silane coupling agent</td>
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<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.15%</td>
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The raw materials used for the epoxy molding compound of each of Examples 1-13 according to the present invention and Comparative Example 1 were weighed up as shown in Table 1. Phenolic resins, waxes and 50% of the silicas were added into a ball mill, and were mixed for 30 minutes under room temperature to get a premixed powder. The premixed powder was then mixed with all the remaining components in a high speed blender, and was mixed for 25 minutes to obtain a mixture. The mixture was put into the feeding bucket of an extruder, and was extruded by a twin screw extruder. The extruded material was further kneaded at about 90-110°C. The material obtained from above was then cooled down, and was crushed into powder.

The obtained powdered epoxy molding compounds were tested for their spiral flow, gel time, adhesion on Cu by tab pull test, volume resistivity, thermal conductivity, electrical conductivity, chloride ion content, failure on high current pulse, delamination on TO220 after IR, and HAST 96 h on TO220 properties, and molded sheet were obtained from each of the epoxy molding compounds for Tg test and CET1 &2 test.

The results of the spiral flow test, gel time test, Tg test, CET1 &2 test, adhesion on Cu by tab pull test, volume resistivity test, thermal conductivity test, electrical conductivity test, chloride ion content test, failure on high current pulse test, delamination on TO220 after IR test, and HAST 96 h on TO220 test of Examples 1-13 and Comparative Example 1 are shown in Table 2.

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<th>Rubber type stress modifier</th>
<th>1.5%</th>
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<tr>
<td>Polyethylene wax</td>
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<td>0.2%</td>
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<td>Fatty acid ester wax</td>
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<td>Carbon black pigment</td>
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<td>Spiral flow (inch)</td>
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<td>29</td>
<td>30</td>
<td>31</td>
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<td>Gel time (s)</td>
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<td>Glass transition</td>
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<td>temperature (°C)</td>
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<td>169</td>
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<td>CTE1 (ppm)</td>
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<td>CTE2 (ppm)</td>
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<td>Adhesion on Cu by tab pull test (N)</td>
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<td>352</td>
<td>347</td>
<td>421</td>
<td>343</td>
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<td>Volume Resistivity ($10^{15} \Omega \cdot \text{cm}$, RT)</td>
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<td>18</td>
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<td>Thermal conductivity (W/mK)</td>
<td>0.72</td>
<td>0.75</td>
<td>0.74</td>
<td>0.72</td>
<td>0.73</td>
<td>0.78</td>
<td>0.79</td>
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</table>
As shown in Table 2, the failure on high current pulse, delamination on TO 220 after IR and HSAT 96h on TO220 of the epoxy molding compounds of the present invention are superior to those of the Comparative Example 1. Thus, it can be seen that, by using the specific components and their specific amounts, the molded products produced from the epoxy molding compounds of the present invention can be used in high current applications, especially in high current TO products, with high reliability.
What is claimed is:

1. An epoxy molding compound, comprising
   (a) 2 to 15 wt.% of an epoxy resin;
   (b) 2 to 15 wt.% of a phenolic resin;
   (c) 60 to 90 wt.% of a filler;
   (d) 0.1 to 0.6 wt.% of a catalyst;
   (e) 0.1 to 3 wt.% of a releasing agent;
   (f) 0.1 to 1 wt.% of a pigment;
   (g) 0.05 to 3 wt.% of a silane;
   (h) 0 to 3 wt.% of an ion trapping agent;
   (i) 0 to 15 wt.% of a flame retardant; and
   (j) 0 to 2 wt.% of a stress modifier;

   wherein the weight percentages are based on the total weight of the epoxy molding compound.

2. An epoxy molding compound according to claim 1, wherein the mole ratio of epoxy groups in the epoxy resin to hydroxyl groups in the phenolic resin is from 0.5 to 1.5.

3. An epoxy molding compound according to claim 1, wherein the epoxy resin (a) is one or more selected from the group consisting of epoxy o-cresol novolac resin, dicyclopentadiene epoxy resin, biphenyl epoxy resin, multi-aromatic epoxy resin, and mixtures thereof.

4. An epoxy molding compound according to claim 1, wherein the phenolic resin (b) is selected from the group consisting of phenolic novolac resin (PN), cresol novolac resin, phenol aralkyl novolac resin, multi-aromatic novolac resin, multi-functional novolac resin, and mixtures thereof.

5. An epoxy molding compound according to claim 1, wherein the filler (c) is one or more selected from the group consisting of crystalline silica, fused silica, spherical silica, titanium oxide, aluminium hydroxide, magnesium hydroxide, zirconium dioxide, calcium carbonate, calcium silicate, talc, clay, carbon fiber, and glass fiber.
6. An epoxy molding compound according to claim 1, wherein the silane (g) is one or more selected from the group consisting of epoxy-containing silanes, methylpropenyl-containing silanes, amino-containing silanes, and mercapto-containing silanes.

7. An epoxy molding compound according to claim 1, wherein the flame retardant (i) is one or more selected from the group consisting of brominated epoxy flame retardants, antimony oxide, organic phosphorus compounds, melamine type flame retardants, aluminum hydroxide, magnesium hydroxide, zinc borate and titanium oxide.

8. A process for manufacturing the epoxy molding compound according to any one of claims 1 to 7, comprising steps of:
   (1) weighing up components (b), (e) and a part of component (c), and mixing them by a ball mill to get a premixed mixture;
   (2) mixing the premixed mixture with all the remaining components in a high speed blender to obtain a mixture;
   (3) putting the mixture into a extruder to extrude it and kneading the same at 90 to 120°C; and
   (4) cooling the material obtained from step (3) down, and crushing into powder.

9. Use of the epoxy molding compound according to any one of claims 1 to 7 as transistor material, printed circuit board material, electronic circuit board material, adhesives, and interlayer insulating materials in electrical and electronic devices.

10. A TO (transistor outline package) product containing a molded product produced from the epoxy molding compound according to any one of claims 1 to 7.
**INTERNATIONAL SEARCH REPORT**

**INTERNATIONAL APPLICATION NO.**

**PCT/CN2015/074603**

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### A. CLASSIFICATION OF SUBJECT MATTER

- C08L 63/00 (2006.01)i; C08K 13/02 (2006.01)i; C08K 3/20 (2006.01)i; C08K 3/36 (2006.01)i; C08K 7/14 (2006.01)i

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

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### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- C08L63/--; C08K13/--; C08K3/--; C08K7/--; C08K5/--

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)
  - CNKI,CNPAT,WPILEPODOC: epoxy,molding, epoxy resin, phenolic resin, filler, silica, titanium oxide, aluminium hydroxide, magnesium hydroxide, zirconium dioxide, calcium carbonate, calcium silicate, talc, clay, carbon fiber, glass fiber, catalyst, curing accelerator, releasing agent, pigment, silane, coupling agent, ion trapping agent, flame retardant, stress modifier

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### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.  

See patent family annex.

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* 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

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Date of the actual completion of the international search:  
06 September 2015

Date of mailing of the international search report:  
30 September 2015

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Name and mailing address of the ISA/CN

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6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China

Authorized officer:  
PEI Shaoping

Facsimile No. (86-10)82246781

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