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ORGANOSILOXANE POTTING COMPOUND

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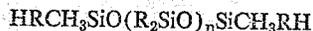
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The present invention relates to organosiloxane potting compounds having unique non-flowing but self-healing properties, methods for the preparation thereof, and electrical apparatus potted or encapsulated therein. This application is a continuation-in-part of my copending application Serial No. 745,270 filed June 30, 1958, and now abandoned.

A wide variety of materials have been used in the past for the so-called "potting," "filling" or "encapsulating" of electrical assemblies. Such materials have ranged from fluids to resinous or rubbery products in form, and are used to provide electrical insulation along with varying degrees of protection from thermal or mechanical abuse. Materials used in this manner in the past have generally not permitted visual inspection of the embedded apparatus, and except where they were actually fluids and hence subject to leakage from their container, they did not permit the electrical testing of components of the apparatus without rupture of the potting compound itself.

It is an object of this invention to provide a potting compound having optical clarity, a fluid nature prior to cure and a soft, tacky, non-friable, jelly-like consistency after being cured. A further object is to provide a material which, although non-flowing in the sense that it will not flow from a container, is self-healing to the withdrawal of a probe, and which has good dielectric properties as well as moisture and thermal resistance.

The above objects have been attained by the organosiloxane gel of the present invention, which can be defined as the reaction product of an intimate mixture consisting essentially of (1) an organosiloxane having a viscosity of from 100 to 10,000 cs. at 25° C. and being a copolymer consisting essentially of units of the formula $RViSiO$, R_2SiO , and $CH_3R_2SiO_{.5}$ where each R individually is selected from the group consisting of methyl and phenyl radicals and Vi represents a vinyl radical, at least 0.174 molar percent of the units in said copolymer being the said $RViSiO$ units, (2) a liquid hydrogenosiloxane of the average general formula



where each R is as above defined and n has an average value such that the viscosity of the hydrogenosiloxane is no more than 10,000 cs. at 25° C., no more than 25 molar percent of the total R radicals present in (1) and (2) being phenyl, and (3) a platinum catalyst in an amount sufficient to furnish at least 0.1 part per million of Pt based on the combined weight of (1) and (2); the proportions of (1) and (2) being such that prior to reaction there is an average of from 1.4 to 1.8 gram atoms of the silicon-bonded H atoms in (2) per gram molecular weight of (1) and there being at least one $RViSiO$ unit in (1) for every silicon-bonded H atom in (2), the molecular weight of (1) being calculated by the equation:

$$\log \text{visc.} = 1.00 + 0.0123M^{.5}$$

where M is the molecular weight and "visc." is the viscosity of (1) in cs. at 25° C.

The reaction which takes place when the above defined materials stand in intimate contact with one another does not evolve gaseous by-products, and hence there are no voids in the gelled reaction product. The final product is a true gel, for it is insoluble in the common organic solvents. It is a rare combination of cohesive strength,

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adhesive properties, elasticity, and non-fluidity which renders its completely non-flowing in respect to the container in which it has been gelled, and which permits deformation under slight pressure. A probe can be inserted into or through the gel with great ease, so that electrical measurements can be taken upon any components which have been encapsulated therein. When such a probe is removed, the "self-healing" character of the gel is such that there is an immediate "flow" into the space formerly occupied by the probe, and there is no evidence of any rupture in the gel.

The combination of non-fluidity (in the one sense) with a self-healing type of flow, along with complete optical clarity and dielectric properties, makes the material eminently suitable for the filling, potting, encapsulating, or impregnating of electronic assemblies, capacitors, condensers, magnetic devices, or any other desired electrical apparatus.

The organosiloxane copolymers defined as constituent (1) above are well-known materials. They can be prepared, for example, by the cohydrolysis and cocondensation of the corresponding halosilanes, i.e. $RViSiCl_2$, R_2SiCl_2 , and CH_3R_2SiCl , or by the copolymerization and equilibration of the corresponding siloxanes. Thus, for example, siloxanes of the formulas $(RViSiO)_4$, $(R_2SiO)_4$, and $(CH_3R_2Si)_2O$ can be mixed in appropriate ratios and heated at 150 to 160° C. in the presence of a catalyst such as NaOH, KOH, or LiOH until an equilibrium is established, then the copolymer neutralized with CH_3R_2SiCl . It is preferred that the copolymer used in this invention be substantially free of silicon-bonded hydroxy groups.

The R radicals in the defined copolymer can be the same or different radicals in each polymeric unit or in the molecule. Thus the copolymer can contain the units $MeViSiO$ and $PhViSiO$; Me_2SiO , Ph_2SiO , and $PhMeSiO$; and $Me_3SiO_{.5}$, $MePh_2SiO_{.5}$, and $Me_2PhSiO_{.5}$ in any combination so long as a representative of each type is present and so long as the viscosity and vinyl content requirements are met and the phenyl content does not exceed 25 molar percent. The symbols Me, Ph and Vi are used here and throughout this specification as representative of methyl, phenyl, and vinyl radicals respectively.

The copolymer (1) should have a viscosity of from 100 to 10,000 cs. at 25° C. This is of course controlled by the amount of the endblocking $CH_3R_2SiO_{.5}$ units present. Preferably this copolymer is substantially free of volatile low molecular weight species. As is well known, however, material of any particular viscosity will itself be composed of innumerable species of molecules having different molecular weights, and it is the viscosity of the mixture of species which is important here. Viscosities of from about 400 to 5000 cs. are preferred.

The hydrogenosiloxane (2) employed herein has the average general formula $HRMeSiO(R_2SiO)_nSiMeRH$, where each R is methyl or phenyl and n is 0 or any positive integer or fraction so long as the viscosity does not exceed 10,000 cs. at 25° C. Thus n can vary from 0 to about 800 inclusive, the upper limit of course varying with the type of R radicals present. Viscosities in the range of from 2 to 2,000 cs. are most preferred. The R radicals in a given molecule or in a given mixture of molecular species falling within this definition can be the same or different radicals. Thus the endblocking units can be $HMe_2SiO_{.5}$ units and/or $HMePhSiO_{.5}$ units, the repeating units if present can be Me_2SiO and/or $MePhSiO$ and/or Ph_2SiO units, and any combination of these endblocking and repeating units can be used. However, when phenyl radicals are present in either constituent (1) or constituent (2) as defined herein, the total number of such phenyl radicals should not exceed 25 molar percent of the total R radicals present in (1) plus (2), with a preferred maximum being about 10 molar percent. It is also pre-