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ORGANOSILOXANE ENCAPSULATING RESINS

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This application is a continuation-in-part of application Serial No. 94,142, filed March 8, 1961, and now abandoned.

This invention relates to transparent flexible organosiloxane casting resins.

Because of their superior thermal stability and electrical properties organopolysiloxanes have long been used to insulate electrical and electronic equipment. When the insulation is in the form of relatively thin films any siloxane resin system can be satisfactorily employed. However, when the insulation is to be used in deep section many siloxane resins are unsuitable. One reason for this is the fact that many siloxane resin systems require a solvent carrier and/or evolve volatiles when they are cured. In both cases the removal of the volatile (either solvent or reaction by-product) precludes cure in deep section since the formation of voids in the cured resin renders electrical properties of the resulting component unsatisfactory. This deficiency cannot be cured by vacuum impregnation since the voids are formed after the viscosity of the resin has reached a point where the volatile material can no longer escape.

There are other siloxane systems which can be cured without the formation of volatiles, but which require the presence of atmospheric moisture. Whereas, these systems do not form voids when cured in deep section, the cure thereof is extremely slow or incomplete due to the fact that atmospheric moisture cannot penetrate into the middle of the resin mass.

Another problem which has long plagued the siloxane encapsulation art has been the high coefficient of expansion exhibited by organosiloxanes. It is 10 to 20 times that of metals normally employed in electrical and electronic equipment. As a result, tremendous stresses are set up in the insulation when the encapsulated system is alternately heated and cooled. Consequently, heretofore employed siloxane encapsulating resins were often unsatisfactory because the thermal cycling caused cracking of the insulation. This cracking could of course be avoided by employing known siloxane elastomers.

However, presently known unfilled siloxane elastomers have an extremely low mechanical strength. That is the tensile strength of an unfilled vulcanized dimethylpolysiloxane is in the order of 50 p.s.i. Consequently, such materials do not have the mechanical strength required for many electrical applications. The mechanical strength of siloxane elastomers can be improved by employing fillers. However, such fillers render the mass either opaque or opalescent. Thus, the electrical components cannot be seen through the insulating mass.

This is a matter of great importance since in many electric systems the individual components are quite cheap, often less than one dollar, whereas, the finished system may be worth thousands of dollars. However, when the material has been encapsulated in an opaque insulating material and one of the cheap components fails, there is often no way of determining which one has

failed. Consequently, the entire system is often discarded.

It is the object of this invention to provide a transparent encapsulating material which has the required mechanical strength and flexibility to give satisfactory service over a wide range of temperature conditions and under severe mechanical stresses. Another object is to provide a material through which the individual components of an electric system can be seen and which will allow replacement of such components without ruining the insulation of the entire system. Other objects and advantages will be apparent from the following description.

This invention relates to a mixture consisting essentially of (1) a polysiloxane of the formula

$$R_2ViSiO\left(\overset{R'_2}{\underset{|}{}}\!\!SiO\right)_nSiR_2Vi$$

in which R and R′ are phenyl or methyl and at least 80 mol percent of the R′ groups are methyl, said siloxane (1) having a viscosity of from 500 to 500,000 cs. inclusive at 25° C., (2) from 5 to 50 percent by weight based on the weight of (1) and (2) of a copolymer of SiO_2, $Me_3SiO_{.5}$ and $Me_2ViSiO_{.5}$ siloxane units in which copolymer there is from 1.5 to 3.5 percent by weight vinyl groups based on the weight of (2) and in which copolymer (2) the ratio of total $Me_3SiO_{.5}$ and $Me_2ViSiO_{.5}$ to SiO_2 units is from .6:1 to 1:1, (3) a compound compatible with (1) and (2) which is a siloxane containing from 0.1 to 1.7 percent by weight silicon-bonded hydrogen atoms, the remaining valences of the silicon atoms in (3) being satisfied by phenyl or methyl radicals, there being at least three silicon-bonded hydrogen atoms per molecule, and in (3) any hydrocarbon radicals attached to an SiH silicon being essentially all methyl radicals, the amount of (3) being such that there is from .75 mol of SiH per mol of vinyl radicals in (1) and (2) to 1.5 mol of SiH per mol of vinyl radicals in (1) and (2), and (4) a platinum catalyst.

The composition of this invention can be room temperature curing or cured by heating. When heating is employed the composition of this invention is best cured at a temperature of from 100 to 200° C., whereupon curing proceeds in one hour or less. It is believed that this curing is brought about by the reaction of the SiH containing component (3) with the vinyl groups in (1) and (2). Preferably the mixture should be used within a few hours after mixing the four ingredients, although the shelf life can be extended for days by cooling to temperatures of −20° C. or below.

The compositions of this invention are fluid materials which are readily pourable and can be used to impregnate complicated equipment. They can also be used to form cast articles of any desired shape.

For the purpose of this invention component (1) is a copolymer of two or more siloxane units. Specific examples of such copolymers are

$$Me_2ViSi(O\overset{Me_2}{Si})_nOSiPh_2Vi,\quad Ph_2ViSi[(O\overset{Ph_2}{Si})_{.1}(O\overset{Me_2}{Si})_{.9}]_nOSiPh_2Vi$$

and

$$MePhViSi[(O\overset{Ph}{\underset{Me}{Si}})_{.1}(O\overset{Me_2}{Si})_{.9}]_nOSiMePhVi$$