OPTICALLY CLEAR SILICONE COMPOSITIONS

The present invention relates to optically clear polysiloxane-based compositions which are employed, in particular, for the manufacture of contact optical articles such as contact lenses, scleral lenses and intraocular lenses.

The spectrum of synthetics employed in contact optics has expanded year by year. Contact lenses have been developed from a very wide variety of materials, for example from PPMA, CAB (cellulose acetate butyrate), copolymers of vinylpyrrolidone etc.

Improvements in the material composition, associated with new lens shapes have been exceptionally beneficial for the use of contact lenses world-wide. In the particular case of lenses with a high water content, optimal gas permeability associated with good fluid exchange has been achieved. The lenses are distinguished by outstanding subjective tolerability. However, for all contact lenses with a relatively high water content it is also necessary to accept disadvantages such as deposition and infiltration of constituents of the tear film, especially of proteins, with possible allergic reactions. In addition, hypersensitivity reactions cannot be ruled out with certain preservatives in the cleansing, wetting and storage solutions.

The highly hydrophilic lens is inferior in optical quality to the hard lens.

It was obvious to look for a soft synthetic whose optical properties correspond to those of hard lenses, for a material which proves to be inert to lacrimal fluid, bacteria and viruses and, moreover, exhibits good physiological tolerability and has a high gas diffusion.

The surface wetting of the hydrophobic silicone rubber material which is necessary for good ocular tolerability was achieved by modifying the molecular structure of the lens surface (for example high-energy radiation or vacuum electron bombardment). Silicone lenses have intrinsically been known for a long time but it soon emerged that, for example, the surface wetting is maintained to only a very limited extent. In addition, other properties of the silicone lenses require improvement.

The present invention now relates to certain addition-crosslinked vinylsilicone mixtures for the manufacture of contact optical articles, in particular of contact lenses, scleral lenses and intraocular lenses. This takes the form of a cold-vulcanizing two-component silicone rubber system in which the basic mixture containing crosslinker is mixed with a catalyst mixture and crosslinked at room temperature or, when the pot life is adjusted to be particularly long, by a thermal impulse (of the order of about 50°–150° C.).

Two-component silicone rubber systems which crosslink on the basis of polydimethylsiloxanes which contain vinyl and SiH groups by addition reaction have been known for many years and are used, for example, as impression and duplicating compositions in dentistry.

These compositions consist of a basic component containing silicone polymer and crosslinker and of a catalyst component composed of silicone polymer, catalyst and inhibitor. The silicone polymer chiefly takes the form of a vinyl-endblocked polydimethylsiloxane, the crosslinker contains reactive SiH groups and the catalyst consists of platinum or a platinum complex. The basic and catalyst components can be adjusted to the same viscosity by specific allotment of silicone polymers with different viscosities. These two components are to be mixed in a defined ratio by weight or volume before use.

The starting substances, such as vinyl-containing silicone polymers, trimethylsiloxy-endblocked polydimethylsiloxanes and polysiloxanes containing SiH groups (crosslinker substances) are prepared in a manner known per se (compare, for example, W. Noll, Chemie und Technologie der Silikone (Silicone Chemistry and Technology), Verlag Chemie, Weinheim, 2nd edition 1964, pages 162–206).

Silicone polymers which have a low oligomer content due to vacuum baking in a thin-film or falling film vaporizer are described in DE-A 3,532,686.

The vinyl-containing silicone polymers generally take the form of vinyl-endblocked polydimethylsiloxanes, that is to say linear polymers. It is likewise possible for the crosslinkers containing SiH groups to be linear. Branches, that is to say a network, are obtained on crosslinking by means of a platinum catalyst if the crosslinker has SiH groups not only terminally but also in the chain. However, the closeness of the mesh of the network is limited in this case, because it is sensible and necessary for the density of SiH groups to remain limited. When the content of vicinal SiH groups in the crosslinker molecule is high, many of these SiH groups are unable to react with the vinyl groups as a result of steric hindrance. Instead of the hoped-for improvement in the elastomeric properties, exactly the opposite is achieved, namely insufficient crosslinking and a plasticizer effect.

Thus, it was desirable to improve the mechanical properties of the materials disclosed in DE-A 3,532,686. Surprisingly, it has now been found that the mechanical properties of these materials, such as hardness, tear strength and elongation at break, are distinctly improved, without this diminishing their optical properties, by addition of 1–10% by weight, preferably 1.5–5% by weight, of low molecular weight QM resins containing vinyl groups.

In addition, the addition of QM resins offers the further advantage that it is possible thereby to alter the refractive index of optically clear silicone compositions.

These QM resins are characterized in that they contain, as explained in the abovementioned book by W. Noll, page 3, the tetrafunctional $SiO_{4/2}$ as Q units and the monofunctional $R_3SiO_{\frac{1}{2}}$ as M building blocks, where R can be vinyl, methyl, ethyl or phenyl. In addition, it is also possible for the trifunctional $RSiO_{3/2}$ to be present as T units and the bifunctional $R_2SiO_{2/2}$ to be present as D units, with the same meaning for R as above. The content, according to the invention, of 1–10% by weight of QM resin, preferably 1.5–5% by weight of QM resin, in the total silicone system brings about a distinct improvement in the density of crosslinking and thus a higher tear strength and hardness of the elastomeric product.

The present invention relates to optically clear silicone compositions which can be cured to elastomers and contain

a) organopolysiloxanes with two or more vinyl groups in the molecule,
b) optionally organopolysiloxanes without reactive groups,
c) organopolysiloxanes with two or more SiH groups in the molecule,
d) catalyst,
e) inhibitor, and optionally further customary additives and auxiliaries,