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Bimodal condensation silicone elastomers as dielectric elastomers

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Lately, dielectric elastomers (DEs) which consist of an elastomer sandwiched between electrodes on both sides, have gained interest as materials for actuators, generators, and sensors. An ideal elastomer for DE uses is characterized by high extensibility, flexibility and good mechanical fatigue as well as high electrical and mechanical breakdown strengths. [1] Most model elastomers are prepared by an end-linking process using a crosslinker with a certain functionality *f* and a linear polymer with functional groups in both ends, and the resulting networks are so-called unimodal networks where unimodal refers to that there is one polymer only in the system. As an alternative to unimodal networks there are the bimodal networks where two polymers with significantly different molecular weights are mixed with one crosslinker. [2]

Silicone rubber can be divided into condensation type and addition type according to the curing reaction. The advantages of condensation silicones compared to addition are the relatively low cost, the curing rate largely being independent of temperature, the excellent adhesion, and the catalyst being nontoxic. [3]

In this work, a series of bimodal condensation silicone elastomers were prepared by mixing different mass ratios (9:1, 8:2, 7:3, 6:4, 5:5, 4:6) between long polydimethylsiloxane (PDMS) chains and short PDMS chains. The resulting elastomers were investigated with respect to their rheology, dielectric properties, tensile strength, electrical breakdown, as well as thermal stability. The bimodal elastomers reinforce themselves at large strain and the high electrical breakdown strength is obtained due both to the low extensibility of the short chains that attach strongly the long chains and to the extensibility of the last ones that retards the rupture process.

Moreover, a series of elastomers with the same mass ratio (7:3) between long and short PDMS chains were made at different humidity (90%, 70%, 50%, 30%, 10%) at 23^{o}C. The dielectric and mechincal properties of the resulting elastomers were shown to depend strongly on the atmospheric humidity level.

In addition, the top and bottom surfaces of the elastomer (7:3) prepared at 23^{o}C and 50% humidity were tested by water contact angle and optical microscope. The results show the bimodal condensation elastomer possesses structural heterogeneity, which may lead to favourable properties for DE applications.

Keywords: bimodal, condensation silicone, dielectric properties, tensile sterngth, electrical breakdown

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