Dielectric elastomers, with very high dielectric permittivity, based on silicone and ionic interpenetrating networks

Dielectric elastomers (DEs), which represent an emerging actuator and generator technology, admittedly have many favourable properties, but their high driving voltages are one of the main obstacles to commercialisation. One way to reduce driving voltage is by increasing the ratio between dielectric permittivity and the Young's modulus of the elastomer. One system that potentially achieves this involves interpenetrating polymer networks (IPNs), based on commercial silicone elastomers and ionic networks from amino- and carboxylic acid-functional silicones. The applicability of these materials as DEs is demonstrated herein, and a number of many and important parameters, such as dielectric permittivity/loss, viscoelastic properties and dielectric breakdown strength, are investigated. Ionic and silicone elastomer IPNs are promising prospects for dielectric elastomer actuators, since very high permittivities are obtained while dielectric breakdown strength and Young's modulus are not compromised. These good overall properties stem from the softening effect and very high permittivity of ionic networks – as high as $\varepsilon' = 7500$ at 0.1 Hz – while the silicone elastomer part of the IPN provides mechanical integrity as well as relatively high breakdown strength. All IPNs have higher dielectric losses than pure silicone elastomers, but when accounting for this factor, IPNs still exhibit satisfactory performance improvements.

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