

## The Influence Of Static Pre-Stretching On The Mechanical Ageing Of Filled Silicone Rubbers For Dielectric Elastomer Applications

Shamsul Zakaria<sup>a, b</sup>, Liyun Yu<sup>a</sup>, Guggi Kofod<sup>c</sup>, Anne Ladegaard Skov<sup>a</sup>

<sup>a</sup> Danish Polymer Center, Department of Chemical and Biochemical Engineering, Technical University of Denmark, Søltofts Plads, Building 229, 2800 Kgs. Lyngby, Denmark

<sup>b</sup> Faculty of Industrial Science and Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Pahang, Malaysia

<sup>c</sup> InMold A/S, Diplomvej 381, 2800 Lyngby, Denmark

### ABSTRACT

Dielectric elastomer (DE) pre-stretching is a key aspect of attaining better actuation performance, as it helps prevent electromechanical instability (EMI) and usually lowers the Young's modulus, thus leading to easier deformation. The pre-stretched DE is not only susceptible to a high risk of tearing and the formation of mechanical defects, but films with sustained and substantial strain may also experience mechanical degradation. In this study a long-term mechanical reliability study of DE is performed. Young's moduli, dielectric breakdown strengths and dielectric permittivities of commercial silica-reinforced silicone elastomers, with and without an additional 35% (35 phr) of titanium dioxide (TiO<sub>2</sub>), were investigated after being subjected to pre-stretching for various timespans at pre-stretches to strains of 60 and 120%, respectively. The study shows that mechanical stability when pre-stretching is difficult to achieve with highly filled elastomers. However, despite the negative outlook for metal oxide-filled silicone elastomers, the study paves the way for reliable dielectric elastomers by indicating that simply post-curing silicone elastomers before use may increase reliability.

**KEYWORDS:** Pre-stretching; Mechanical ageing; Silicone composite; PDMS; Dielectric elastomer

**DOI: [10.1016/j.mtcomm.2015.08.002](https://doi.org/10.1016/j.mtcomm.2015.08.002)**