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Electro-spraying and ultra-violet light curing of polydimethylsiloxane to fabricate thin films for low-voltage dielectric elastomer actuators

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Currently, dielectric elastomer actuators (DEA) are mainly based on micrometer-thin polymer films and require operating voltages of several hundred volts. In medical applications, however, voltages as low as a few tens of volts are required. To this end, we prepared nanometer-thin dielectric elastomer layers. It is demonstrated that alternating current, electro-spray deposition allows for the fabrication of homogenous, flat, nanometer-thin polydimethylsiloxane (PDMS) films. The growth of the PDMS with average number molecular weights ranging from 800 to 62,700 g/mol, at a constant flow rate of 267 nL/s, was in situ monitored by means of spectroscopic ellipsometry. The Cauchy layer model used for data interpretation may only be applied to flat PDMS layers. Thus, in the present study the droplet morphology was also determined by atomic force microscopy. Spectroscopic ellipsometry does allow for the qualitative determination of the thin film morphology. However, for high molecular weight polymers the precise measurement during deposition is challenging. Independent of the molecular weight, the roughness of the deposited PDMS films considerably smoothens during the ultra-violet radiation treatment. After curing, the electro-sprayed nanometer-thin PDMS films are homogeneous enough to qualify for the fabrication of low-voltage DEA.
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