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Polydimethylsiloxane films engineered for smart nanostructures

*Tino Töpper[a], Bekim Osmani[a], and Bert Müller[a]

[a] Biomaterials Science Center, Department of Biomedical Engineering, University of Basel, 4123 Allschwil, Switzerland

*Corresponding author: tino.toepper@unibas.ch

Abstract

Herein, we present organic molecular beam deposition to fabricate (sub-)micrometer-thin polydimethylsiloxane (PDMS) substrate-fixed films with a thickness homogeneity better than 2% on square centimeters. Their surface roughness and wrinkle morphology is controlled by the evaporation temperature, the growth rate, and the ultraviolet-light irradiation. The tailoring of the elastic modulus for the selected vinyl-functionalized PDMS nano-membranes is demonstrated. Both the surface morphology and mechanics are key parameters, which crucially determine the tissue-to-implant interactions for applications in bioelectronics. The cross-linked PDMS nano-membranes with elastic moduli of only a few hundred kPa are realized – a compliance similar to human soft tissues. The *in situ* characterization of their mechanical properties is presented based on their temperature sensitivity by spectroscopic ellipsometry and correlated to subsequently performed nano-indentation using a sophisticated atomic force microscopy instrument. Such soft sub-micrometer-thin elastomer membranes will become an essential component of dielectric elastomer transducers with strains comparable to human muscles, operated at the conventional battery voltages for future artificial muscles or skin implants.

Keywords: *(Sub-)micrometer-thin polymer membrane, Biomimetic film properties, Thermal expansion, Organic molecular beam deposition, Spectroscopic ellipsometry, Atomic force microscopy-based nano-indentation.*