Using NOA81 in microtransfer molding of nanogrooves

R. Sabahi-Kaviani, A.J. Bastiaens, R. Luttge
Neuro-Nanoscale Engineering, Department of Mechanical Engineering, and Institute of Complex Molecular Systems, Eindhoven University of Technology, Eindhoven, 5612AZ, the Netherlands
r.luttge@tue.nl

Brain-on-a-chips (BoC) have emerged rapidly in the bioMEMS field to enhance our knowledge of neuro-degenerative diseases and their potential therapeutic interventions.[1-3] Recently, we contributed to this field by functionalizing BoCs utilizing replica molding of nanogrooves with a pattern period of 600 nm, ridge width of 230 nm and a height of 100 nm.[4] Additionally, NOA81 was introduced by us recently as a cost-effective material in the fabrication of microsieve-based BoCs.[5,6] Aiming to extend our BoC toolbox, here, we apply the PDMS mold making protocol from our previous work[4] (Figure 1a) for NOA81 microtransfer molding of nanogrooves (Figure 1b-d). Microtransfer molding is known as a variation of soft lithography to assemble a wide range of micro- and nanopatterned materials in 2D/3D spatially organized platforms.[7] By spin coating NOA81 on the PDMS mold (Figure 1b) at 12000 rpm for 60 s, we created a film of approximately 3 µm thickness, which was partially cured at a UV-dosage of 200 mJ/cm^2 (Figure 1c). After microtransfer molding the film, for example, onto a microscope glass slide, the assembly was exposed to UV with a dosage of 2000 mJ/cm^2 before peeling off the PDMS mold (Figure 1c). Finally, the nanogrooves in NOA81 are fully cured with a dosage of 6000 mJ/cm^2 (Figure 1d). In all three exposure steps the UV lamp was set to an intensity of 15 mW/cm^2. Atomic force microscopy (AFM) of the PDMS mold and its resulting NOA81 relief, respectively, confirmed the presence of nanogrooves despite a diminished pattern fidelity using the PDMS mold as a reference (Figure 2a-c). The process is also briefly demonstrated for microtransfer molding of nanogrooves to other surfaces, e.g. using a spin coated NOA81 film on a microscope glass cover slip as such type of a substrate (Figure 2c). Additionally, scanning electron microscopy (SEM) provides us with a similar impression (Figure 2d). A detailed analysis of loss in pattern fidelity will be performed next but may solely result from the PDMS mold rather than being related to the material properties of the UV-curable NOA81. In conclusion, using NOA81 in microtransfer molding of nanogrooves will also allow us to introduce such cell guidance patterns onto other bioMEMS substrates in BoCs, like microelectrode arrays.

---

[1] C. Forro et al., Micromachines **12**, (2021).
[2] T. Osaki et al., Adv. Healthc. Mater. **7**, 1 (2018).
[3] P. Nikolakopoulou et al., Brain **143**, (2020).
[4] A. Bastiaens et al., J. Vac. Sci. Technol. B **061802**, (2019).
[5] E. Moonen, R. Luttge, and J. P. Frimat, Microelectron. Eng. **197**, 1 (2018).
[6] R. Sabahi-Kaviani and R. Luttge, Micromachines **12**, 1 (2021).
[7] X. Zhao, Y. Xia, and G. M. Whitesides, J. Mater. Chem. **7**, 1069 (1997).

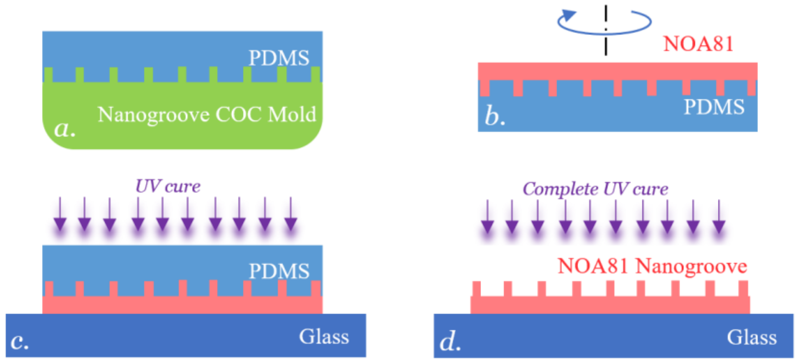

Figure 1: Schematic representation of the fabrication process: (a) Replication of nanogroove to PDMS as previously demonstrated by Bastiaens et al.[4], (b) then to thin NOA81 by spin coating at 12000 rpm. (c) Transfer of nanogroove patterns on glass substrate and UV curing the assembly by 2000 mJ/cm^2. (d) Removing the PDMS mold and completely cure the assembly by UV light with 6000 mJ/cm^2.

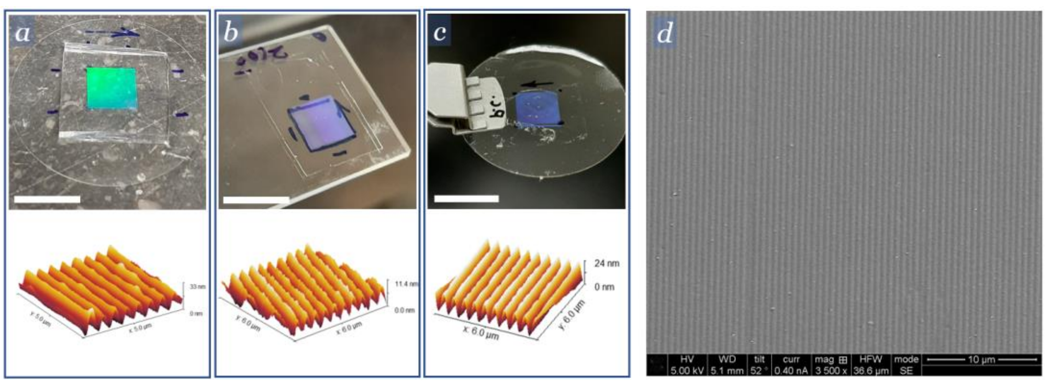

Figure 2: Nanogroove patterns are visible by the appearing color due to interference and the AFM measurements, respectively. (a) Nanogrooves in PDMS mold. (b) Microtransfer molded NOA81 nanogrooves on a microscope glass slide. (c) Microtransfer molded NOA81 nanogrooves on flat NOA81 substrate. Scale bars:1 cm for a-c. (d) SEM image of the microtransfer molded NOA81 nanogrooves on a flat NOA81 substrate.