# Multiple replication of hierarchical structures from polymer masters with anisotropy

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Hierarchical structures find a lot of applications ranging from tribology to optics[1]. When these structures, in addition, feature anisotropy, this specific quality renders directionality to the interaction properties induced by these structures. Here we address the realization of a direction-dependent adhesion.

Typically the preparation of hierarchical structures may be complex. Applications hence ask for a replication of such structures to multiply the number of samples on hand; there are materials available that have specifically been developed for the purpose of replication, as e.g. OrmoStamp[2]. However, often a situation is met where the original exists as a polymeric template only; Fig. 1 exemplifies this by hierarchical structures obtained by optical lithography with subsequent laser treatment. Then the question arises whether standard replication procedures work with such delicate polymeric templates, in particular when multiple replication is employed to obtain a large number of samples from a single template which, at worst, may be lost. This is the focus of our work.

This investigation relies on two replication materials, OrmoStamp and SU-8. SU-8 layers on Si are also used to characterize all replication results, as these samples can easily be cleaved for cross-sectional inspection. Fig. 2 illustrates the experience gained when the template is already from OrmoStamp. Only the copy into a different material (here SU-8) is successful, whereas the copy into the same material (OrmoStamp) fails. When OrmoStamp and SU-8 are used alternately, the number of replication steps can be chosen almost at will.

We will investigate the multiple replication process according to Fig. 2 with the polymeric templates shown in Fig. 1. Characteristic issues in this context are the limited adhesion and the limited chemical inertness of the photoresist. Feature distortion is also an issue, as a number of subsequent replications is required to end up with the target tone (positive/negative) and the target material.
Finally PDMS membranes with these structures are prepared and characterized by adhesion measurements under shear, similar to those of Fig. 3.

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[1] M. Tormen at al, Nanotechnology **18** (2007) 385301.
[2] M. Mühlberger et al, Microel. Engin. **86** (2009) 691; H. Schift et al, JVST **B27** (2009) 2846.

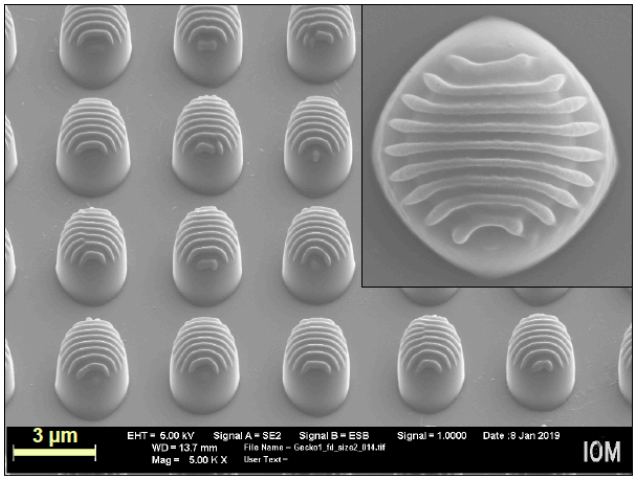


*Figure 1: Hierarchical polymeric template.* Preparation in photoresist by lithography and subsequent laser treatment resulting in self-ordered LIPSS (laser-induced periodic surface structures).

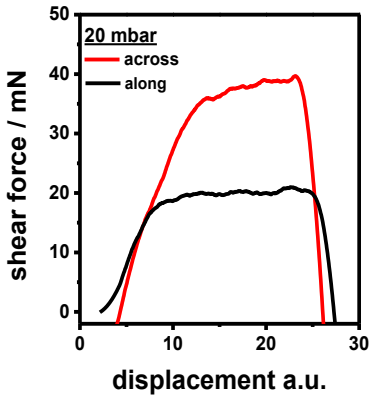


*Figure 3: Adhesion with anisotropic hierarchical structures* (here 1 µm wide lines on 20 µm square posts).

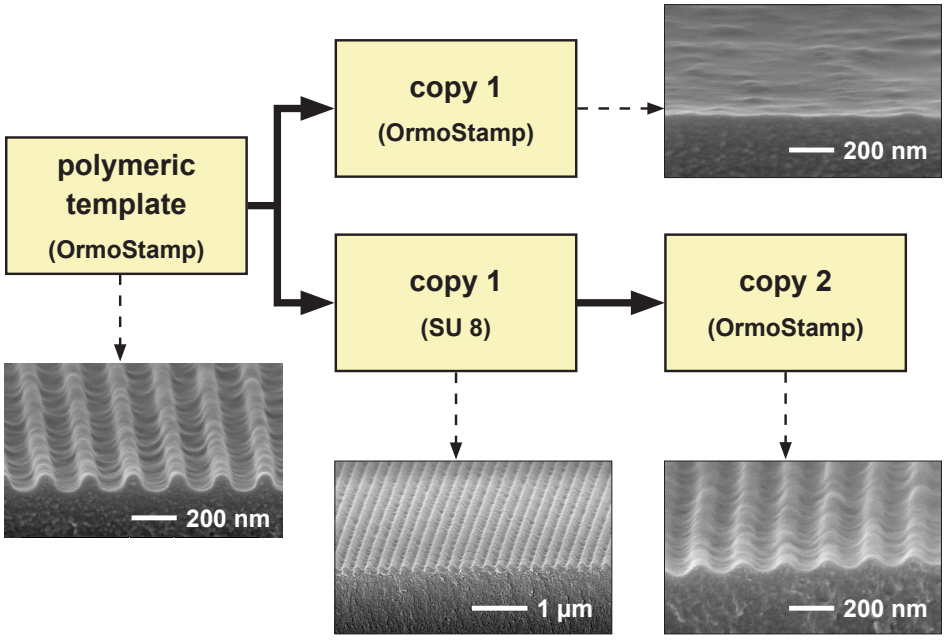


*Figure 2: Multiple replication of polymeric templates in OrmoStamp and SU-8.* Successful repeated replication advises alternating the replication materials. Feature distortion is critical when a specific tone of the structures in a specific material is aimed, as it asks for repeating this replication cycle several times.