Studies on the fully automated printing/imprint process using a double-side patterned soft stamp

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Nanoimprint lithography is an attractive technology for the fabrication of diffraction unlimited patterns due to its simple process, low cost and high throughput. Nanoimprint with soft stamps attracts currently more interest due to its many advantages. Unfortunately, the soft stamps trend to deformation when imprint forces are added. This deformation occurs both in the macro aspect (unevenness of the imprint resist layer through the whole imprint area) and in the micro aspect (deformation of single structure). These deformations will be transferred directly to the imprint resist after its curing and thus influence the imprint results. In our previous work [1] we studied the deformation behaviors of the soft stamps in dependence of the template geometry and imprint process parameters with FEM method.

Based on the results of the FEM study, we present in this work a double-side patterned (DSP) soft membrane stamp consisted of PDMS with a glass background. The patterns in nm range are located on the outside of the membrane for nanoimprint. A glass background with mask patterns are directly imbedded in the membrane and the mask patterns are aligned to the nano patterns. Such double-side patterned soft membrane stamps can be simply molded with a special casting station in one step only with heating process. The thin glass works both as a hard support for the soft membrane to reduce the stamp deformation and as masks for photolithography to confine the UV-Curing only in the nano-pattern area.

The DSP stamp is the key component of our automated µCP/NIL platform. The sizes of the membrane and the glass background are matched well so that both the flexibility of the stamp and the uniformity of the residual layer are ensured. The glass background in the middle of the membrane reinforces the hardness of this area and thus balances the membrane deformation. The rest PDMS around the glass background ensures the flexibility of the membrane for self-leveling. This stamp construction is the base of our novel press-relax imprint process to minimize the stamp deformation and is the base of the vacuum-pressure-assisted demolding process, which enables an automated NIL process. The mask patterns in the glass background are aligned to the nano patterns and thus enable the UV-curing only in these areas. With this DSP stamps we demonstrated successfully nano gratings (200nm) confined in a hexagon (Fig.1).

[1] Jian He ; S. Howitz ; S. Killge ; K. Richter ; J. W. Bartha; Deformations of soft imprint templates in the nanoimprint lithography. Proc. SPIE 8323, Alternative Lithographic Technologies IV, 83231B (March 1, 2012);

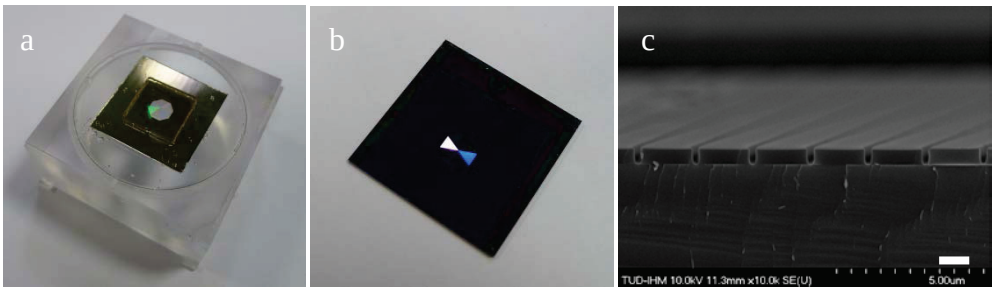

Figure 1: a) DSP stamp of PDMS, b) nano gratings (200nm) confined in a hexagon, fabricated with the DSP stamp, c) SEM picture of the nano gratings, the bar is 1 µm.