A New Molding Process to Fabricate Silicon Reinforced PDMS Masters

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PDMS is a biocompatible, ultra-violet transparent, and gas permeable elastomer that has been widely applied in the micromachining field. In particular, it has been used as the master material in soft lithography for pattern transfer. PDMS is soft and flexible, enabling it to have intimate contact with substrates and consequently making good pattern transfer to those substrates. On the other hand, due to residual stress induced in the molding process, PDMS may have large residual deformations that lead to a misalignment problem, i.e., the patterns are not generated at the designed locations. To solve the misalignment problem, it is necessary to reduce the residual deformations of PDMS by increasing the stiffness.

Particles or fibers are often used to reinforce a material. In those applications, the average stiffness of the reinforced material has increased due to the contribution of the reinforcements. Using a similar idea, we developed methods to reinforce PDMS using stiffer SU-8 particles and SU-8 truss structures. A silicon plate was further used instead of the SU-8 because of its much larger Young’s modulus and smaller thermal expansion coefficient than SU-8. It could reduce the residual deformations of PDMS masters to zero in principle. However, we faced a key obstacle (i.e., a peeling-off problem) in generating a Si reinforced PDMS master using a conventional molding process, in which PDMS is first coated on and then peeled off from a rigid mold. When a Si plate of a large size is needed and embedded in the PDMS, the reinforced PDMS master becomes rigid and is difficult to peel off due to limited flexibility of Si. In this work, a new molding process is developed to overcome this obstacle. An SU-8 structure is firstly made on a flexible transparency (Fig. 1a) using a standard ultra-violet lithographic process. The SU-8 mold is placed on and then peeled off from a rigid PDMS master. In such a way, a Si reinforced PDMS master of a size as large as a 4in wafer can be produced (Fig. 1b). Meanwhile, a new way of releasing SU-8 structures is presented. Figure 1c shows a released SU-8 structure by this molding process.

Figure 1: (a) an SU-8 mold on a transparency, (b), A Si reinforced PDMS master with air bubbles at the edges of the pattern area and (c) a released SU-8 mold (structure).