Experimental

Materials*:* Standard 4-inch single crystal (SC) silicon wafers are supplied by Okmetic (Vantaa, Finland). Sylgard 184 from Dow Corning is used to prepare PDMS. For the experiments, PLLA 2003D grade is purchased from Natureworks (Minnetonka, Minnesota), with Mw = 126000 Da, determined by size exclusion chromatography measurements. Dichloromethane (DCM) (anhydrous > 99.8%) is supplied by Sigma Aldrich (Copenhagen, Denmark). Poly acrylic acid solution (average M_w ~ 100,000, 35 wt% in H_2O) and polyethylene glycol pellets (average Mn = 6,000) are also obtained from Sigma Aldrich (Copenhagen, Denmark).

Polymer film solutions and spin coating*:* Firstly, prepolymer and the curing agent are mixed in 10:1 ratio to make PDMS mixture. After that, once the bubbles are removed, PDMS solution is spin coated on a standard Si wafer using WS-650-15 Spin coater (Laurell Technologies) at 500 rpm speed and 500 rpm/s acceleration for 60 s. The PDMS layer is hard baked at 90 ºC overnight on a hot plate resulting in 80 µm thickness. For process A, the PDMS is treated with UV/Ozone for 30 min.

PLLA solution (15 wt%) in dichloromethane is prepared and kept on a hotplate at a temperature of 50 °C for at least 24 h. During heating constant magnetic stirring is applied to achieve a homogeneous polymer solution. The solution is cooled to room temperature before spin coating. The PLLA solution is dispensed on a silicon wafer rotating at 100 rpm. The wafer is then accelerated with 300 rpm/s to the final spin speed of 300 rpm which is maintained for 60 s. The resulting film thickness measured after 2 h of degassing in a fume hood is around 100 µm.

For the PAA-PEG solution, 4 g PEG is added to 20 mL of 35 wt% PAA solution in water. A clear PAA-PEG solution (44 wt% with 2:1 ratio) is obtained by stirring it for 3 h at room temperature. This solution is then spin coated on a clean Si wafer at 1000 rpm speed and 500 rpm/s acceleration for 60 s to get a layer of 80 µm thickness. The wafer is then kept at room temperature overnight.

Hot embossing and thermal bonding: The Ni stamp is used to emboss the PLLA film at 90°C for 15 min under 1.9 MPa pressure. The pressure is maintained during the cooling stage. The stack of Ni stamp and PLLA film is cooled down to 50 °C, demolding is performed and the microcontainer patterns are replicated in the PLLA. PLLA containers are bonded to PAA-PEG layer at 60 °C for 15 min under 1.9 MPa pressure, cooled down to room temperature and demolded. Both processes are performed using a custom-made hydraulic press machine and the entire setup is kept at ambient pressure.

Characterization: The cross-sectional profile measurements of the microcontainers are acquired using confocal mode in optical profilometry (Sensofar PLu Neox 3D). The thicknesses of the polymer films are measured using contact profilometry (Mitutoyo Stylus thickness measurer). The micrographs are taken using SEM Zeiss Supra 40 VP in variable pressure mode and SEM JEOL JSM 5500LV in high vacuum mode.