Step-and-Repeat Thermal Nanoimprint Lithography as Tool for Upscaling of Nanostructured Surfaces

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Nanoimprint lithography[1] (NIL) is a next generation lithography technique capable of patterning sub-10-nm features[2] at high throughput rates. NIL is a one-to-one process meaning that any pattern which is structured on a master will be transferred to the imprinted substrate. The master (generally in silicon), which is manufactured using ebeam lithography and reactive ion etching, costs several thousands of euros. Step-and-repeat (S&R) NIL process (Fig. 1) allows to upscale structures contained on the master stamp (1x1 cm^2) on larger surface, with a tremendous reduction of costs.

Here we present the S&R thermal NIL process, which was used to pattern different substrates (4 or 6 inch Si wafers coated with PMMA and 15x15 cm^2 square PC plates). The nature of this technique allows one to selectively transfer the nano structures in predefined position while the versatility of this technique allow one to emboss in bulk polymer sheets. Line structures in nm range (Fig. 2) and honeycomb structures (Fig. 3) in sub-µm range were realized. Subsequently the structured NIL samples were metallized and galvanically replicated by nickel electroforming (Fig. 2). Thereby an upscaling of the structured surface on large area nickel shims was generated. In a next step the fabricated nickel shims have been tested for roll-to-roll polymer replication, for flex foil fabrication regarding NIL process on large curved surfaces or for inserts moulds.

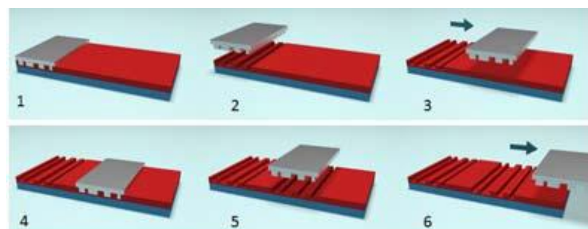

Fig. 1: Step-and-repeat nanoimprint lithography

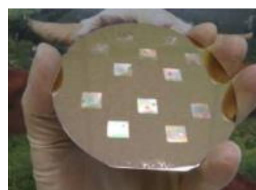

Fig. 2: Nickel shim (after electroforming of a 10 cm diameter silicon wafer coated with PMMA; patterned by S&R thermal NIL)

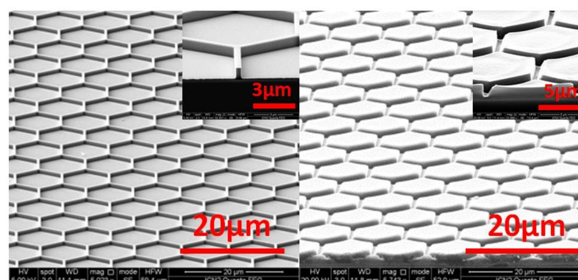

Fig. 3: SEM images of sub-µm honeycomb structures (opposite polarity) patterned by S&R thermal NIL

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References

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