

SOFT-SUBSTRATE-RIGID-FEATURE (SSRF) NANOIMPRINT LITHOGRAPHY

Nano Imprint Lithography (NIL) is done by two main approaches, depending on the mold material. In hard NIL, the molds are produced by lithographic patterning and etching of rigid materials (Silicon or Quartz). These molds achieve CD of a few nm and show excellent pattern fidelity. However, rigid molds are extremely sensitive to surface contamination and defects. Alternatively, soft molds made by cast and curing of elastomer materials (mostly Poly(Dimethylsiloxane) - PDMS) offer highly conformal contact, low sensitivity to surface contamination, and the ability to imprint on curved surfaces, such as optical lenses. However, the compressibility of elastomeric molds makes the pattern features deform, buckle, or collapse, resulting in pattern distortion and limited resolution

In this work, we introduce a novel concept of hybrid Soft-Substrate-Rigid-Feature (SSRF) nano imprint mold, which is based on soft substrate with rigid relief features. Our approach combines the advantages of the both traditional molding approaches, and at the same time overcomes their drawbacks. Specifically, SSRF mold provides a unique combination of: (1) High pattern fidelity and small feature size as offered by hard molds and (2) low sensitivity to defects and ability to pattern curved substrates as offered by soft molds.

The SSRF mold was fabricated by electron-beam lithography of Hydrogen Silsesquioxane (HSQ) on a sacrificial substrate, followed by transferring the obtained HSQ features to elastomeric PDMS substrate. Anti-adhesive coating, which is usually used for hard Si based molds, was successfully applied on SSRF mold, and was shown to be essential for the mold durability. The pattern was demonstrated by nano imprint of UV-curable resist. In summary, we demonstrate here a novel concept of robust, high-quality, and low-cost nanoimprint lithography, which will pave a way to the broad variety of applications impossible up today.