Sub-100 nm three dimensional diffractive optical elements fabricated by UV light assisted roll to roll nanoimprint lithography

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We report on the fabrication of three dimensional (3D) sub-100 nm features using UV light assisted roll to roll (R2R) nanoimprint lithography. The features have been fabricated in a 500 nm thick Ormostamp material which has been coated on a flexible PET substrate. The fabricated structures could be used as passive diffractive optical elements.
Direct imprinting of three dimensional (3D) structures is a challenging aspect of nanoimprint lithography (NIL). The main drive for 3D fabrication is the cost reduction as the number of process step needed to build a device is reduced. Moreover the requirement for even more compact devices generates an additional need for 3D nano-manufacturing. Throughout the last years consumers needs have created new trends and requirements for their products. The need for flexible, light weight, energy saving and low cost products have lead the nano-manufacturing industry to look into new technological platforms and therefore move from the rigid technology to flexible processing technology.
For our processing we used a desk top size UV light assisted R2R system manufactured by PTMTEC ltd. (figure 1). During our experiments we used flexible PDMS stamps which were replicated from a Si master mould. Figure 2 shows top view scanning electron microscope (SEM) images of our two and four layer Si master stamps. As imprinting material we used a thinned Ormostamp resist from *microresist technology GmbH* that was reverse gravure coated onto a 100 mm wide PET substrate (500 μm in thickness). Prior the UV imprinting we baked our material with a IR heating unit which ensured that no solvent had remained in our resist. After coating and curing a R2R nanoimprint lithography (NIL) step was carried out. During the R2R NIL step UV light was applied through the back side of the substrate to ensure that our resist was fully cross linked. Figure 3 shows top view SEM images of our two and four layer structures imprinted at a speed of 0.7 m/min. Efforts for increasing the imprinting speed are under progress.
In conclusion we have fabricated 3D nanoscale diffractive optical elements by means of UV light assisted R2R nanoimprint lithography. Unlike parallel processing R2R nano-manufacturing opens new trends and approaches for inexpensive meter per meter processing at the nanoscale.

Acknowledgment

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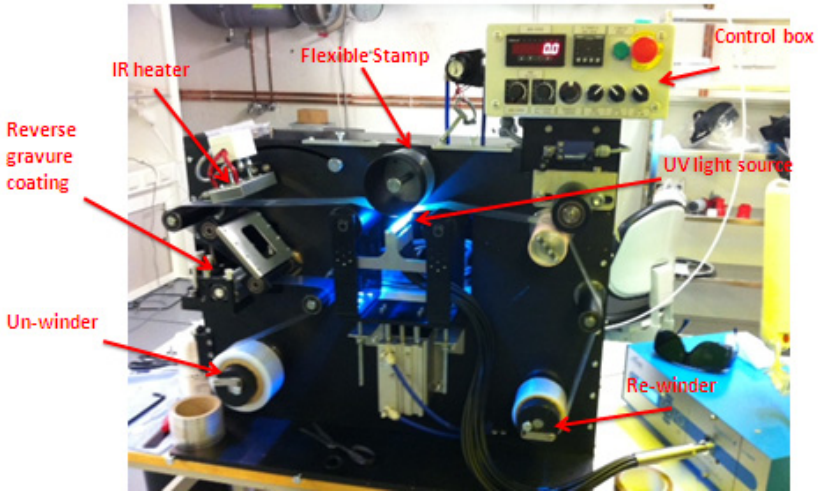

Figure 1 R2R UV light assisted nanoimprint machine installed in ICN.

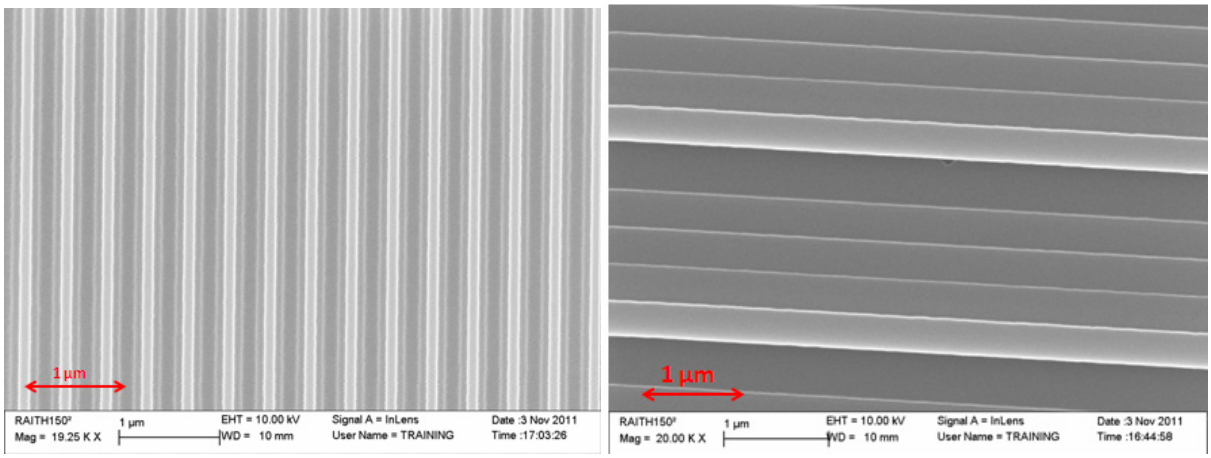

Figure 2 (left) two layers Si stamp used during our experiments, (right) 4 layers Si stamp used during our experiments.

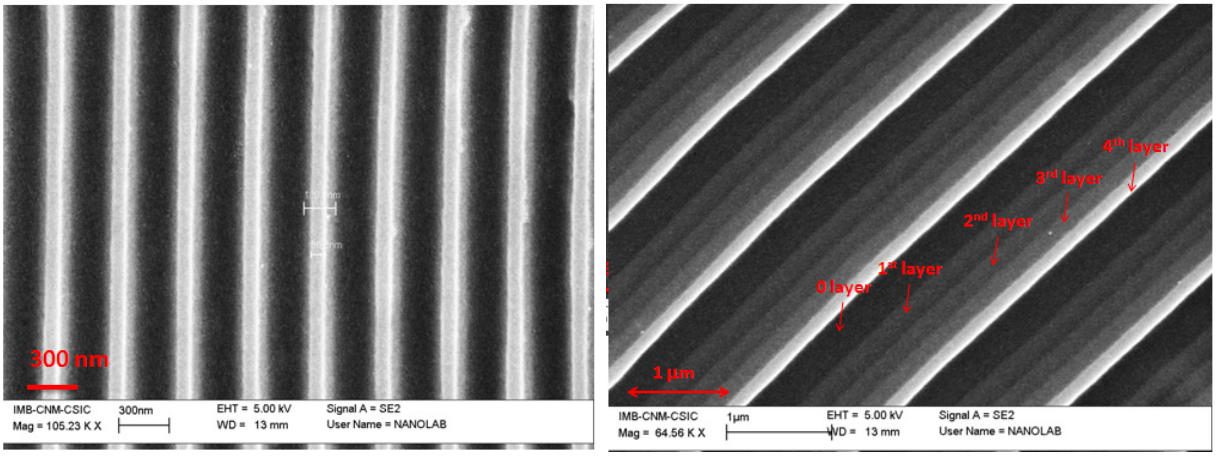

Figure 3 Three dimensional features with sub-100 nm resolution perfomed by R2R UV-NIL in Ormostamp resist on a flexible PET substrate.