Step and Repeat UV nanoimprint lithography with sub-15 nm resolution and sub-5 nm residual layer thickness

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UV Nanoimprint Lithography (UV-NIL) technology is a very attractive technology to reproduce micro/nano-patterns over large area at low cost [1]. The Step&Repeat approach for UV-NIL allows reaching high throughput and is currently in industrial preproduction phase for various applications such as hard disks [2]. One of the highest patterning resolution reported at this time is by Toshiba Corporation using a UV-NIL stepper with 18 nm isolated lines [3]. We present here a method combining the advantages of Step&Repeat technology and the imprinting of spin-coated films.

Thin films of low-viscosity UV-curable polymer resist (mr-UVCur21xp) from Micro Resist Technology are spin coated on 6 inch silicon wafers and imprinted with a UV-NIL steeper (MII Imprio 55). The process is performed at low pressure ($P<0.8$ bar), no vaccum and short exposure times (120s). The residual layer of imprinted patterns is easily controlled by initial spin coating conditions. The template consists of HSQ (Hydrogen Silsesquioxane) patterns, down to 10 nm minimum feature size, directly written by Electron Beam Lithography on quartz substrate. Examples of imprinted structures are depicted in Figure 1 and 2. We demonstrate the imprinting of gratings 14/40 nm linewidth/picth and residual layer thickness down to 2 nm. The very thin residual layers allow an easy pattern transfer as reported in Figure 3.

The present method allows patterning large area with sub-15 nm feature sizes and controllable residual layer. At the difference of conventional stepper processes, the resist is spin coated on full wafer allowing a careful control of the residual layer and doesn't need an additional transfer layer. As next step, the method will use for fabrication of nanophotonic devices.

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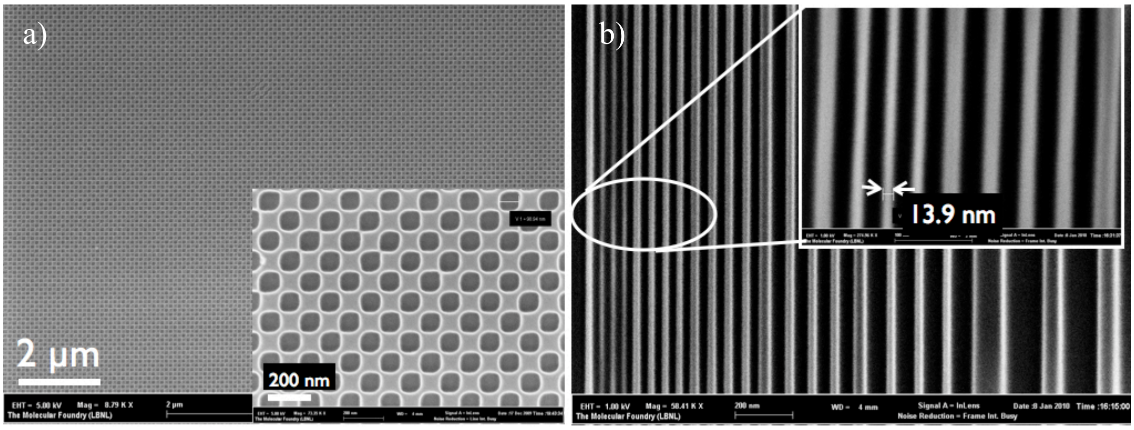

Figure 1.: Scanning Electron Microscope picture of imprinted patterns: a) dots gratings (Ø/p=100/200nm), b) gratings with variable pitch and linewidth

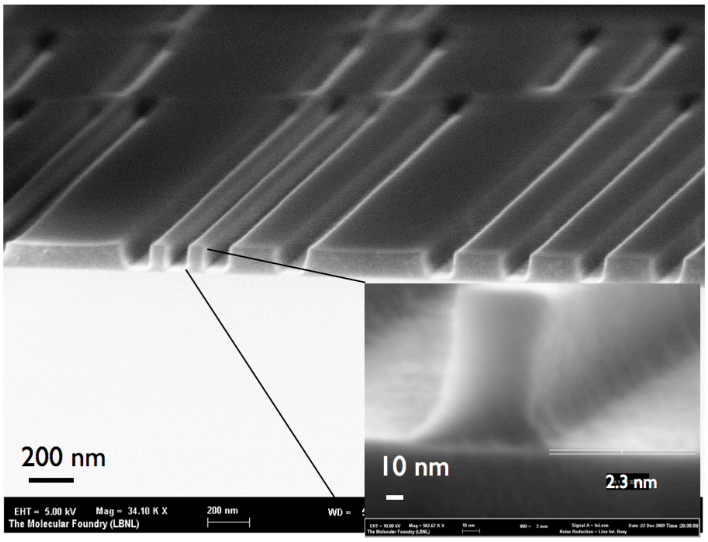

Figure 2.: SEM cross-section picture of a specific pattern with sub 3nm residual layer. The height of the pattern is around 105 nm.

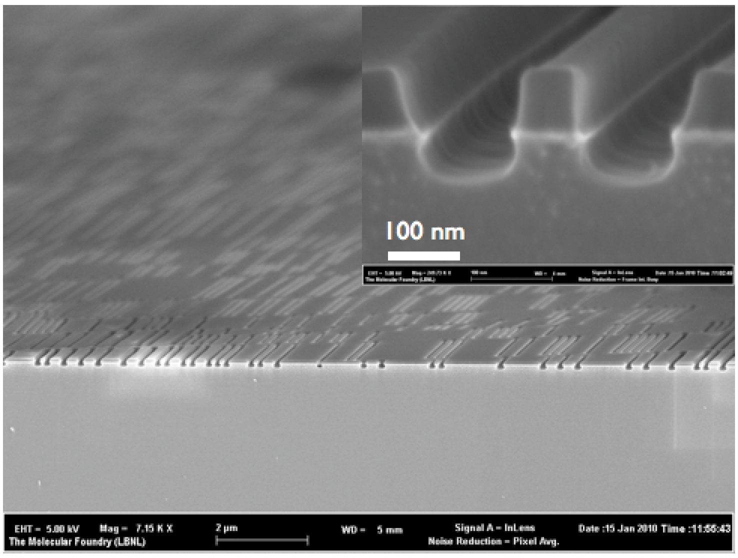

Figure 3.: SEM cross-section picture of pattern transfered by Reactive Ion Etching into silicon for 50 nm depth.