UV-Nanoimprint Process Using Home-Developed Resist And Multi-Scale Molds

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In order to achieve the ITRS roadmap predicted trends, that is to say constant diminution of the features width, one must develop new lithographic techniques. Among the possible Next Generation Lithography (NGL) techniques, there are conventional lithography that try to reduce the features width by reducing the wavelength of the source; and non-conventional lithography like nanoimprint lithographies. Among these, UV curing NanoImprint Lithography (UV-NIL) is seen as a promising NGL because of its high throughput, high resolution and alignment capabilities. However, to use UV-NIL, new processes must be developed to fabricate high-resolution features on UV transparent molds and a low viscosity resist with UV curing properties must be used. Then only, the quality of the imprints and the control of the residual resist layer can be studied.
We will present the process developed to produce multi-scale features on a fused silica mold; the home-made resist completing UV-NIL criteria; and to finish, some imprint results using these mold and resist on an EVG620 imprint tool.

Micro- and nano-scale features were combined on the molds by processing successively optical and electron beam lithographies on 100mm diameter and 650µm thick fused silica substrates preliminary coated with a 20nm thick chrome layer. The patterns were then transferred in the chrome layer using an inductive coupled plasma dry etching tool, with Cl_2/O_2 gazes. The fused silica was etched using the chrome layer as a hard mask in the same reactor with CF_4, C_4F_8 and Ar gazes. Proper conditions led to 150nm deep features with minimal CD bias, maximum angle and a minimum micro-trenching, as observed in Figure 7. After the removal of the chrome, the fully transparent mold with 3D features on one side was treated with an appropriate anti-sticking layer.

The UV-NIL resist must complete the following criteria: low viscosity, UV curable, spin coated or drop dispensed and resistant to an etch transfer. We fabricated a mixture of a pre-polymer, a photoinitiator and a solvent which complete the low viscosity, UV curable and spin coating criteria. The spin curve of this resist, the NILTM105, is presented in Figure 8.

Using these mold and resist, some imprints have been performed on an EVG620 imprint tool. This tool allows handling up to 100mm-diameter substrates and molds. The imprint process runs as following: loading of the mold and the spin coated substrate, contact done with planarity compensation, pressure applied up to 900 mbar, 60sec of contact at the set pressure, 3 sec of UV exposure and separation and unload of the mold and the substrate. We demonstrate that both micro-scale patterns and patterns smaller than 50 nm can be produced at the same time with such a process, as shown in Figure 9. Measurements of the mold features (array of lines 130/70nm) and the associated imprinted area (60/140nm) done with a top view Scanning Electron Microscope (SEM) also show an excellent fidelity between mold and substrate (typical results are shown in Figure 10).

We will present other results on the optimisation of the process. It will be shown how a 30 nm uniform residual layer can be obtained on the whole wafer.

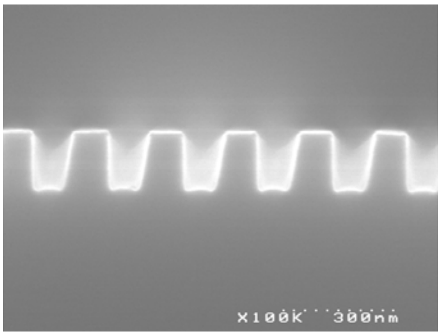

Figure 7 – SEM cross section picture of the etched fused silica. Array of 100/100nm lines, 150nm high.

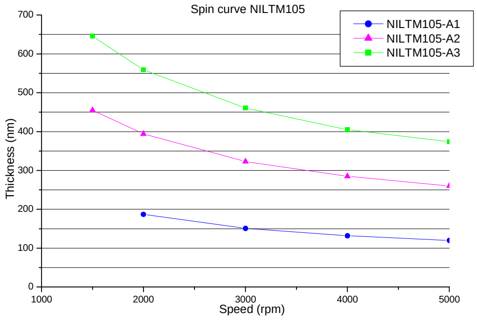

Figure 8 – Spin curves of three dilutions of our home-made resist: NILTM105

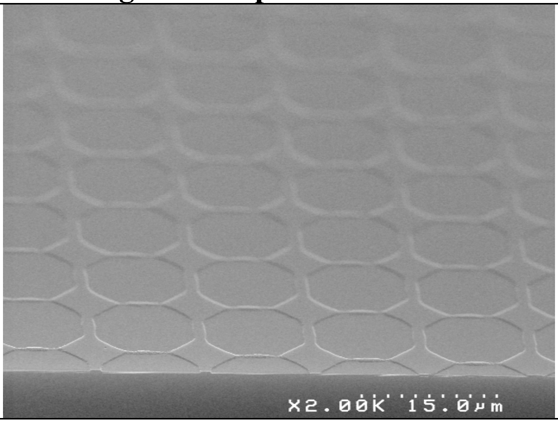	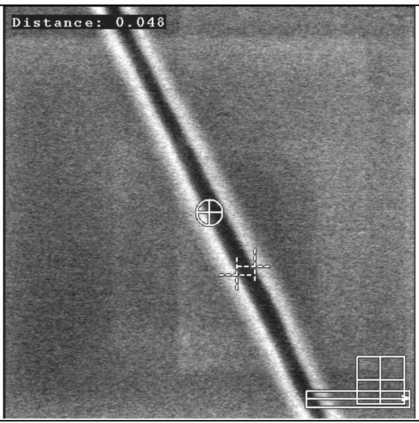
3-a SEM picture of an array of micro-scale holes	3-b Top view SEM picture of a 48nm isolated line

Figure 9 – Micro- and nano-scale imprinted features

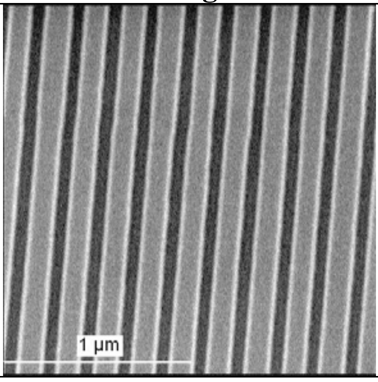	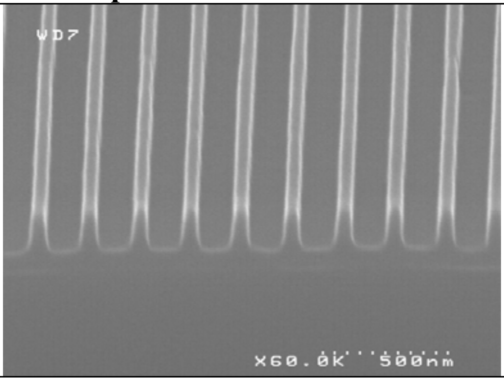
4-a Top view SEM picture of the mold	4-b SEM picture of the imprinted features

Figure 10 –Fidelity between mold and imprinted features