Process development for UV step and repeat nanoimprint lithography using an HSQ-based nanopatterned mould

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Nanoimprint Lithography (NIL) is now established as most promising emerging lithography technique in term of nanopatterns definition and cost-efficient technology. As several kinds of processes exist, several kinds of templates with nanofeatures are needed. While hot embossing NIL uses etched silicon moulds, UV based processes use thick silica moulds. The main difficulty is then to properly transfer the nanopatterns into the thick material by the mean of plasma etchings. A common way is to use a thin chromium layer into which the electron beam defined patterns are first transferred. This metallic layer is then used after as etch mask for the etching of the quartz material. This technique remains difficult and may generate a large numbers of defects. In order to avoid the etching step of the quartz, a versatile process to fabricate nanopatterned moulds for UV-NIL process can be used[1]. It is based on the use of an inorganic resist, the hydrogen silsesquioxane (HSQ), which presents the advantage to be close to the SiO_2 after thermal or plasma treatments. It is also a negative-tone electron sensitive resist which allows the definition of nanopatterns by electron beam lithography.

The specific mould used in our UV lithography tool is depicted in Figure 1. Because of thick insulating substrate the fabrication process begin by the deposition of 30nm thick transparent conductive layer, then 120 nm thick layer of HSQ resist is coated and patterned by E-beam exposure. The resist is then developed with a MF 702 solution. Thanks to the conductive layer, the SEM observations are easier. Figure 2 shows 60 nm isodense gratings after HSQ development. AFM measurements were also performed in order to evaluate the roughness of patterns. The porosity of the patterned HSQ was investigated with several thermal or plasma treatments (Table 1). It appears that thermal treatments allow to completely changing the HSQ resist into SiO_2-liked material. We can then expect that the HSQ patterns will efficiently non porous and hard to support the imprint process.

A global process will be presented. Compatible anti-sticking layers with the HSQ mould will be evaluated. Imprinted features, achieved with our EVG UVNIL tool, with AFM and SEM observations, will be also discussed.

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1. D.P. Mancini and al., *JVST*, 20(6), Nov/Dec 2002, p. 2896-2901

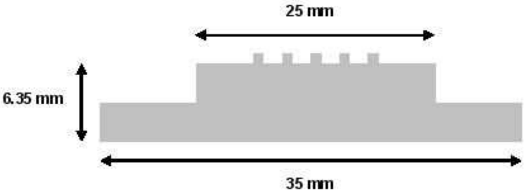

Fig.1 : Specific mould used in our SFIL tool

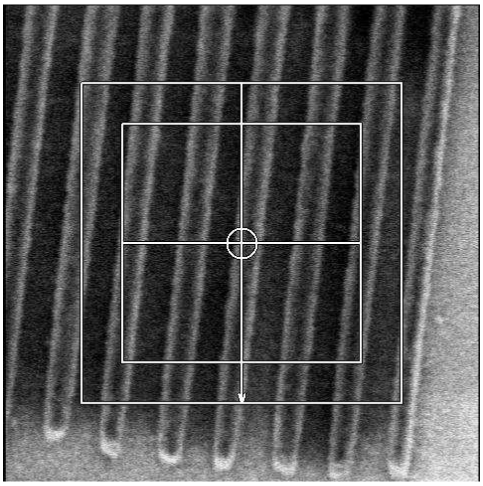

Fig.2 : SEM observations of HSQ patterns 60nm lines/space

	Thickness (Å)	Refractive index @ 633 nm	Open porosity (%)
30' @ 400°C	1380	1.398	5.3
30' @ 575°C	1148	1.45	0
30' @ 750°C	1097	1.473	0
O_2 treatment	1393	1.413	0
No treatment	1427	1.404	5.4

Table 1: Evolution of the HSQ properties as a function of treatments