Pattern transfer on 200mm Si wafer for optical application

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NanoImprint Lithography is a very promising technique to duplicate nanoscale patterns for several kinds of optical applications. The objective is now to lead this lithography to a mature state for industrial applications. This implies a high control of all process parameters, printing uniformity and optimization of a specific transfer process. The printing process on 200 mm wafers has already been studied [1], and this paper will present the capability and limitations of direct transfer into the underneath substrate by plasma etching on several resist chemistries. The imprinted patterns used for this study are lines and pillars as shown on the SEM images of figure1.

In order to look in more details at the shape of printed lines, some 3D Atomic Force Microscopy characterizations were performed to determine top rounding and sidewall angle [2]. The figure2 is a 3D AFM view (left) of a 250 m width printed polymer line. More over, scatterometry measurement is used to determine the residual layer thickness (Hr). Scatterometry and AFM measurements are both needed to fully characterize the quality of printed lines.

This work presents characterizations of the etching rates for different polymers dedicated to industrial applications. In a first time we targeted to control the Hr etching thus we studied the impact of the plasma chemistry on the resist pattern transferred fidelity (table1, figure3). The results show a huge influence of plasma chemistries on the transferred pattern's profile (top rounding, sidewall angle).

The residual layer etching is crucial for application of NIL into industrial processes, special studies have been performed on this step to analyse its anisotropy. It has been shown that using different plasma chemistries, the profile of the pattern can be well controlled for several resists, with no significant change of the structure dimensions (figure3). Depending on the etching chemistry, pattern size can be guaranteed or modified. First result shows that the most promising processes are based on $O_2/Cl_2/Ar$ or O_2/HBr gases.

It will be presented that anisotropy processes can be used to etch simultaneously different patterns presenting different Hr.

[1] N. Chaix, S. Landis, C. Gourgon, S. Merino, V.G. Lambertini , G. Durand, C. Perret, Nanoimprinting lithography on 200 mm wafers for optical applications, Microelectronic Engineering 2007.

[2] J Foucher, K Miller, Study of 3 D metrology techniques as an alternative to cross-sectional analysis at the R & D level, Proc. SPIE, Volume 5375, pp. 444-455 (2004).

Figure 1: 240/260 nm lines and 440 nm wide, 650 nm high pillars imprinted in the NEB22 resist

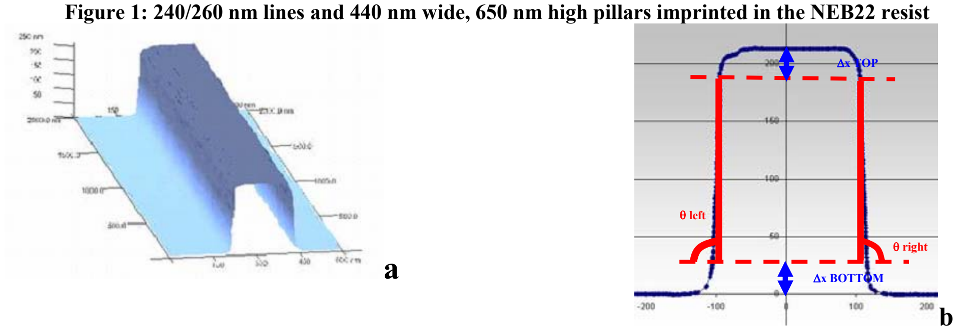

Figure 2: a: Atomic Force Microscopy image of a 220 nm printed line and its corresponding cross b: cross section profile of the line and defines the parameter Δx_{top} and Δx_{bottom} and the two side wall angle θ_{left} and θ_{right} used to characterize to the printed patterns.

	NEB22	mr-I7010	mr-I7010E	Si
$O_2/Cl_2/Ar$	3 nm/sec	4.1	3.1	
$HBr/CL_2/O_2$	2	1.9	2.2	4.2

Table 1: Etch rates of several polymers (Sumitomo NEB 22, MRT: mr-I)

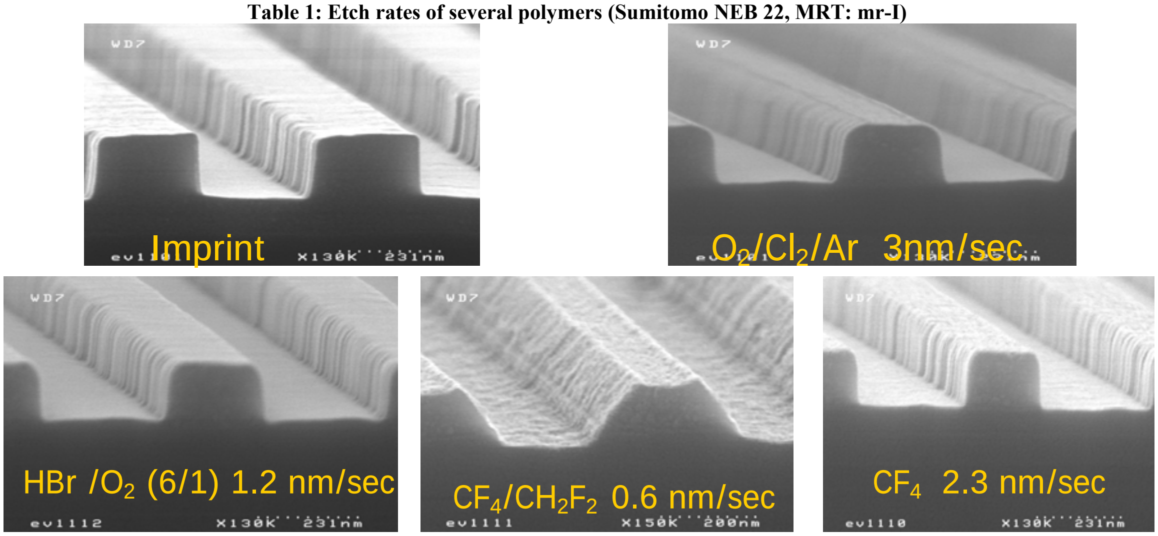

Figure 3: Residual layer etching using different plasma chemistries

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