Real-time demolding characterization of high throughput imprint

T. Leveder[a], S. Landis[a], L. Davoust[b], S. Soulan[c], J.-H. Tortai[c], N. Chaix[c]
[a] CEA/LETI - Minatec - 17 rue des martyrs, 38054 Grenoble, France
[b] LEGI/ENSHMG, 1025 rue de la piscine Dom. Univ. BP 53, 38041 Grenoble
[c] CNRS-LTM, 17 rue des martyrs, 38054 Cedex 9 Grenoble, France

Nanoimprint lithography (NIL) is henceforth known has a promising emerging lithography, as for high resolution patterns[1], as for complex 3D shapes[2]. Even though pattern quality has reached up adequate level; industrial use of NIL is requesting a significant improvement of manufacturing throughput.

Demolding of a hot embossing substrate at imprint temperature allows reaching a higher throughput. Indeed, heating and cooling steps usually take longer times than printing (i.e., active) time. Without these steps, the process will be quicker. Nevertheless, at the imprint temperature (above the glass transition temperature Tg), the pattern quality may be affected by the resist reflow. In order to characterize the behaviour of resist patterns during such a demolding, we used two specific measurement techniques.

First, 3D AFM measurements[3] have been performed on quenched patterns to know very accurately few time steps (fig. 1). Then, to get a real-time characterization of the reflowing patterns, we backed an imprint and simultaneously used a multi-wavelength ellipsometer. Scatterometry computations are based on the simultaneous measurements of 32 wavelengths spectra. Sampling time of 50 ms ensures a real-time measurement. Thanks to both of these techniques, we finally got a real-time full geometrical characterization of patterns; height, sidewall angle and top rounding respectively (fig. 2).

A demolding at imprinting temperature obviously implies a fall of pattern quality. Knowing, the temperature and time dependencies of the resist flow, we will show that it is possible to choose a printing and demolding temperature and a quench velocity to keep the required pattern quality (fig. 3).

We will show that the knowledge of reflow velocity according to temperature is a basic criterion of choice in order to determine the best process window for hot temperature demolding. Thanks to our approach we will be now able to optimize the process throughput by determining the one temperature high enough to have a good printing and low enough to have a quick demolding.

[1] Landis, S., Chaix, N., Gourgon, C., Perret, C., Leveder, T., "Stamp design effect on 100 nm feature size for 8 inch NanoImprint lithography", *Nanotechnology* 17 (10), pp. 2701-2709

[2] Beauvais, J., Lavallée, E., Zanzal, A., Drouin, D., "Fabrication of a 3D nano-imprint template with a conformal dry vapor deposited e-beam resist", *Proc SPIE*, 5751 (I), pp. 392-399

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

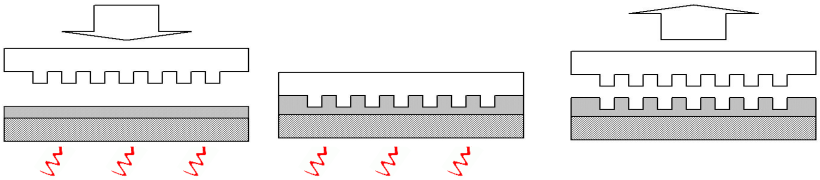

Figure 1-1: Imprint (T>Tg) and demolding (T<Tg) steps.

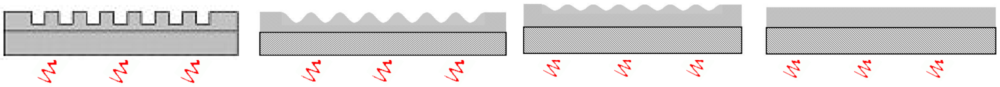

Figure 1-2: Post demolding backing step and lines reflowing (T>Tg) during scatterometer and AFM measurements.

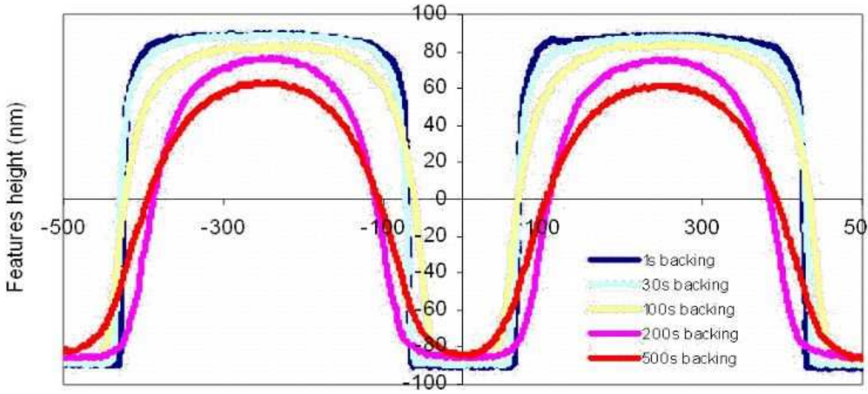

Figure 2: evolution of the resist shape for different post demolding backing time, but same temperature (80°C). Resist is Micro Resist Technology product: MRI 7010E.

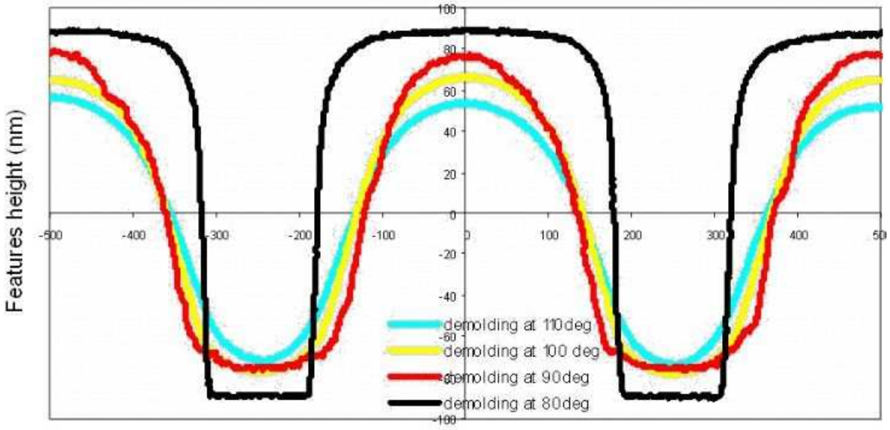

Figure 3: evolution of the resist shape for different post demolding backing temperature, but same times. Resist is Micro Resist Technology product: MRI 7010E, and 80°C is clearly an optimal demolding temperature.