8” and 12” wafer scale Nano Imprint Lithography: from process control to optical functions

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Many applications in micro/nano-devices ranging from electronics, biological, optical, mechanicals, fluidics structures benefit from miniaturization to reduce costs and increase functionalities. However, the fabrication schemes that microelectronics had boosted for decades for the production of integrated circuits, based essentially on layering and planar patterning stacks of semiconductors, metals, and dielectrics, do not apply straightforwardly to the new emerging fields of applications that required three dimensional 3D micro-nanostructures. Currently, the major challenge in 3D lithographic technologies is to find a standard low cost and high resolution fabrication technology that is capable of 3D patterning with minimum lithography steps.

Techniques for the fabrication of high resolution three-dimensional nano-objects do already exist, such as gray-scale electron beam lithography [1], laser ablation, focused ion beam lithography [2], two photon polymerization [3] or more complex approach using liquid instabilities [4]. These sequential methods are suitable for the fabrication of advanced device prototypes, however, for mass production, they suffer dramatically from lack of throughput. Generally, in order to face effectively the challenges of mass production, a sequential lithographic technique (used to manufacture stamp for example) is coupled to a parallel technique (NIL as patterning technique for example) capable of reproducing an entire pattern or structure at once. As a consequence, the fabrication of stamps with 3D reliefs over large areas, i.e.200 mm or 300 mm wafer scale, still represents an extremely demanding task.

In this paper we present the development of the 3D Si stamp manufacturing and corresponding imprint processes over 300 mm wafer size. We will show how high resolution 193 nm optical lithography and dry etch processes can be used to produce 3D sub 100 nm features size patterns with overlay accuracy below 20 nm. A large number of patterns shapes and density (> 150) were manufactured and thermally imprinted in thin thermoplastic and thermoset materials with 200 mm and 300 mm imprint equipments. Using both hard and soft 3D stamp we pointed out the impact of mechanical stamp properties on the 3D polymer flow during imprint processes.

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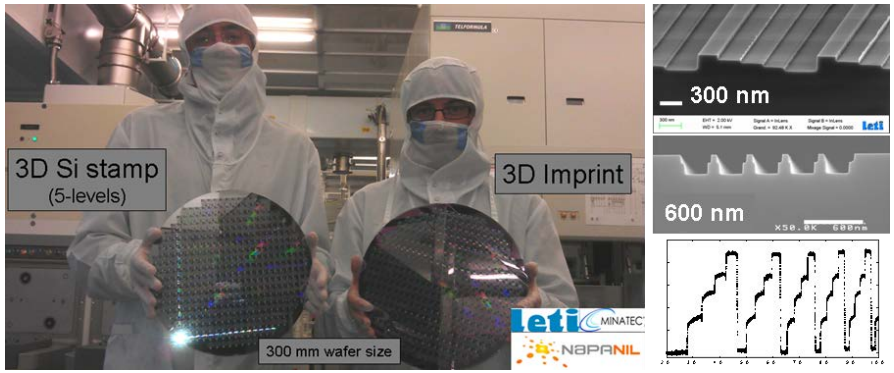

Figure 1. Picture of 300mm 5 levels 300mm Si stamp and corresponding imprinted wafer SEM pictures of multilevel stamp and profilometry characterization.