Breaking R2R NIL Mastering Barriers: Speed, Precision & Cost

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This paper presents an overview of the state of the available nano imprint lithography mastering approaches in terms of speed, precision and cost together with their respective limitations. We show our work with results breaking barriers in speed and precision for any arbitrary 3D pattern. We show scaling direct write lithography with nickel plating for producing masters and nickel stamps from sizes measured square centimeters flat to seamless cylindrical R2R square meters.

Almost every project exploring Nano Imprint Lithography begins the same way. A master is made utilizing semiconductor technologies. Sometimes it is made is with a an e-beam written mask with photo lithography steps on a wafer followed by ion beam milling, RIE, and subsequent lift off or etch steps. Alternatively, that mask is made with tools from vendors such as Heidelberg, SPS, Nano-scribe creating a gray scale 3D photo resist pattern. The results of most of these mastering efforts is a precision pattern on a relatively small area on a flat silicon or glass substrate from which a PDMS stamp is most often fabricated. For research and for some applications this yields all that is required. However, for commercialization of many products which require large areas, a long lasting, large area, affordable stamp is required and is frequently a significant barrier.

Our work is built leveraging tools from the fields of optical lithography, optical recording, and precision machining. With these tools we push the boundaries of optical direct write resolution together with high feature transfer rates. How do we push direct writing smaller than wavelength? How do we write much faster? We will show our latest results in terms of speed and precision breaking the barriers for cost effective scale-up together with a roadmap of what to expect in the near future.

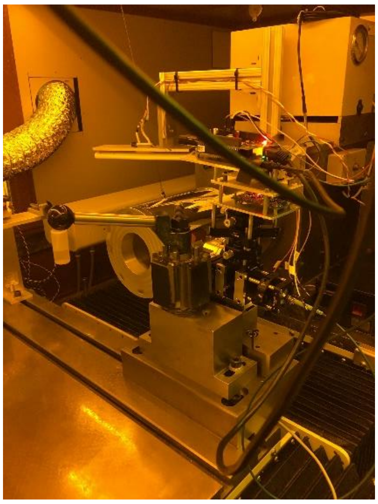

Figure 4 Mastering System 1

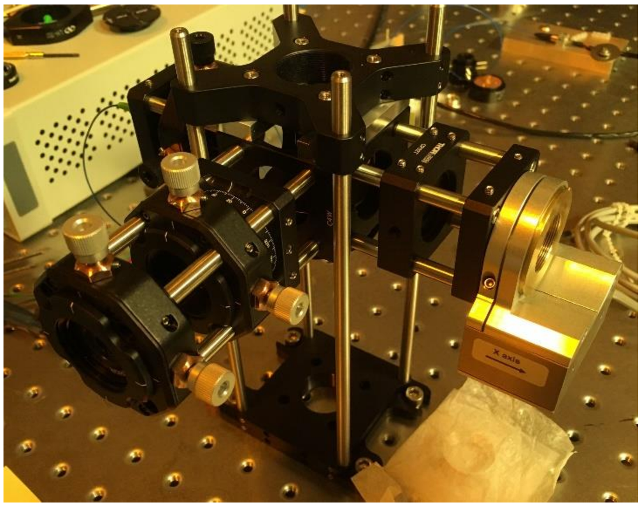

Figure 3 Laser Writer Head

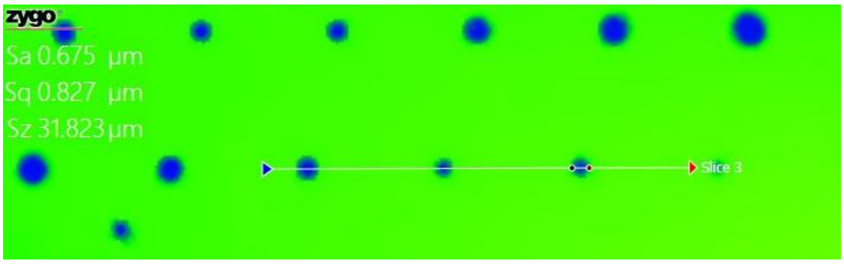

Figure 2 Isolated Written Cone Array - First Run (Developed)

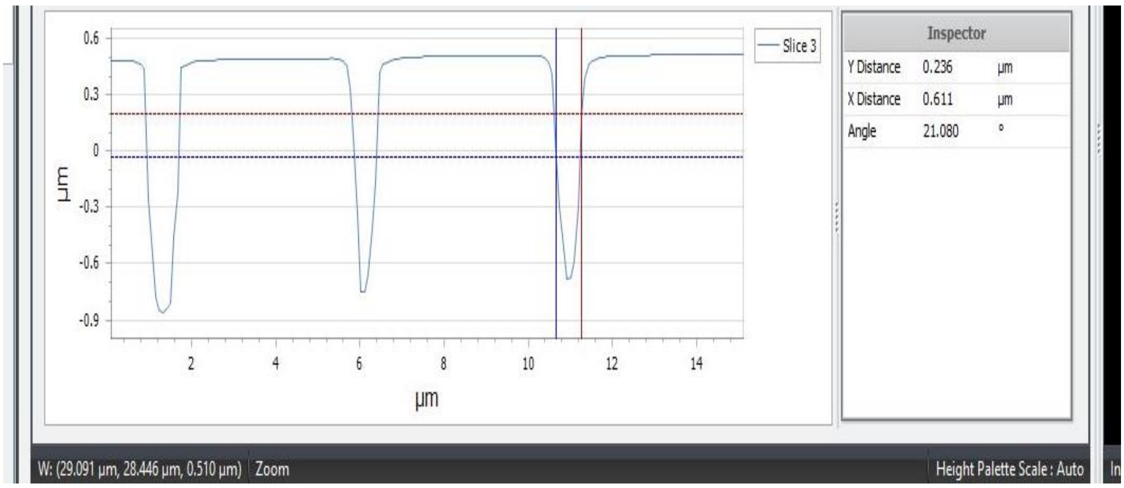

Figure 1 1.2 micron Cones measuring at predicted .6 micron FWHM (with .4 NA)