Substrate Conformal Imprint Lithography. High volume NIL production with functional resists.

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Nanoimprint lithography (NIL) is a technology that can deliver cost effective fabrication of sub-micron and nano-patterns on large areas. From the wafer-scale NIL methods the soft-stamp based methods have remained and are now dominating the field. Wafer-scale NIL is targeting mainly non-semiconductor applications where substrate bow and thickness variation, topology from underlying layers and particle contaminants complicate the use of hard/rigid stamps over wafer scale areas, due to reduced stamp lifetime and yield.

Substrate Conformal Imprint Lithography (SCIL) developed by Philips solves the limitations of soft-stamp based NIL techniques (resolution, pattern deformation, overlay) and allows low-pressure wafer scale conformal contact and sub-10 nm resolution using a novel silicone rubber stamp assembly. Our imprint resist offers additional functionality (chemical, physical) which lowers the total cost of ownership of the total patterning process. [1] SCIL is used since 2008 for the mass production of GaAs based vertical cavity surface emitting lasers (VCSEL) in which SCIL lowers the cost per laser, while increasing the efficiency. [2]

We will discuss a new 200mm AutoSCIL tool, which was installed at our customer and has a new fully integrated full wafer overlay alignment. Currently we are validating this next generation tooling which includes overlay capability with a specification of 1 micron in X,Y over 200mm wafers. In this contribution, the challenges for overlay alignment due to the SCIL imprint principle will be discussed, Fig. 1A and B shows the tool with a close-up of the stage and optics.

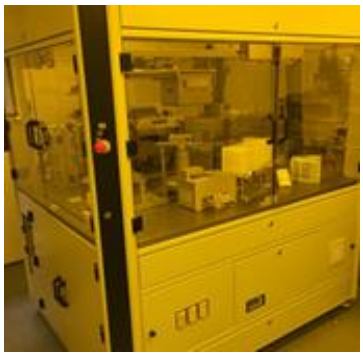
Currently, there is high interest in large area nano-photonic optical components for so-called meta-surfaces and artificial- / mixed-reality applications. Both applications require sub-micron patterns with a high refractive index and sub-5nm control over pattern geometry. The silicone rubber stamp allows direct patterning of complex features in functional resists with a high index of refraction. This enables a cost down as vacuum layer depositions and transfer etching are not required anymore. Figure 2A shows the range of refractive indices address by our inorganic resists and 2B. SEM images of directly patterned high index slanted gratings

Finally, we progressing to predict the nano-mechanical behavior of our soft stamps as many applications require directly imprinted patterns with aspect ratios over 4 with sub-100nm dimensions.

References

1. Marc A. Verschuuren, Mischa Megens, Yongfeng Ni, Hans van Sprang and Albert Polman, Adv. Opt. Techn. 6(3-4) 243–264 **(2017)**
2. M A Verschuuren, P Gerlach, H A van Sprang and A Polman, Nanotech 22 505201 **(2011)**

A.



B.

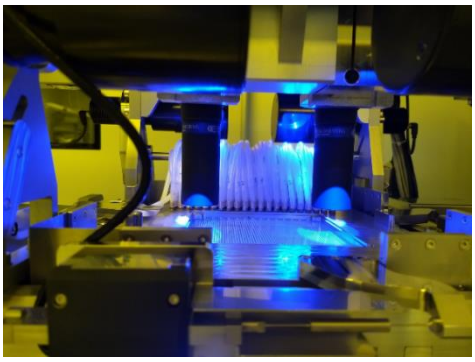
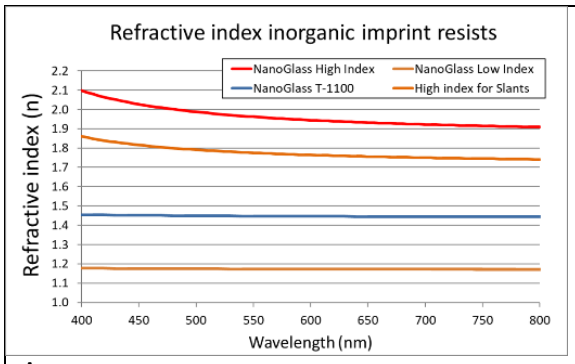
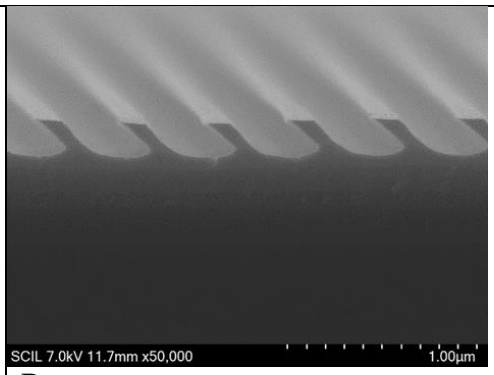


Fig. 1. A. AutoSCIL 150 tool. B. Overlay alignment stage and optical inspection system.



A.



B.

Fig. 2. Dispersion of inorganic NanoGlass resist types, ranging from n=1.15 to n=1.95 and SEM images of high index material gratings.