High Volume Nanoimprint Lithography technology and applications

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Nanoimprint lithography (NIL) has developed from an emerging nano replication technology into a matured and industrially viable manufacturing technology. In order to fully take advantage of its possibilities, it is important to be able to produce nanostructures with an excellent quality in every imprint, a low residual layer, a low amount of defects and the ability to use the stamp for as many imprints as possible. In addition, the process must be flexible with a potential to use different micro or nano patterns on various types of substrates.

Obducat's IPS®/STU® manufacturing process can easily handle imprints on silicon substrates, flexible substrates and rough substrates due to the fact that no hard materials touch each other during the entire process sequence, see figure 1. The IPS® material is flexible, which allows the stamp to adjust to the curvature and roughness of the substrate, thereby giving a uniform residual layer on a full wafer scale.

In order to show that NIL has advanced to a stage where it is ready to be included in industrial manufacturing, 8000 imprints were produced using a single stamp in a fully automated nanoimprint lithography system, Sindre® 400. Measured data from the imprinted substrates shows consistent results throughout the imprint series. Figure 2 shows the average pitch as a function of number of imprints between imprint number 2000 and 4000. The values for the average pitch were found by performing AFM measurements in five points on the wafer and taking the average thereof. In addition, the figure also shows the minimum, maximum and average value for the stamp as lines. It is clear that the imprint process is stable and reproducible throughout the series.

The stamp was characterized in order to investigate the potential degradation of stamp quality. Dark field optical microscopy images shows that the number of defects accumulated on the stamp throughout the process is very small, see figure 3. The yield from the nanoimprint lithography step was calculated by evaluating the area fraction of defects on the stamp. After 8000 imprints, the yield from the nanoimprint lithography step was found to be 99,15 %.

This paper will also show examples of applications based on the use of different types of substrates such as III / V substrates (LEDs) and flexible substrates (organic electronics).

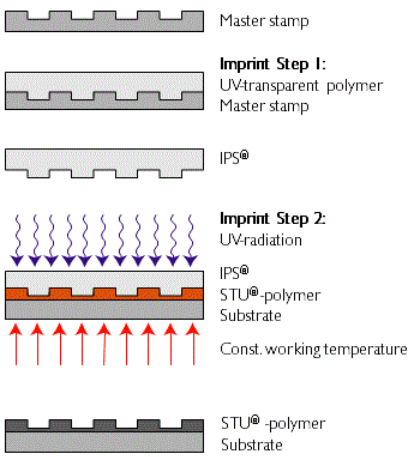

Fig. 1 Process flow for the IPS-STU process.

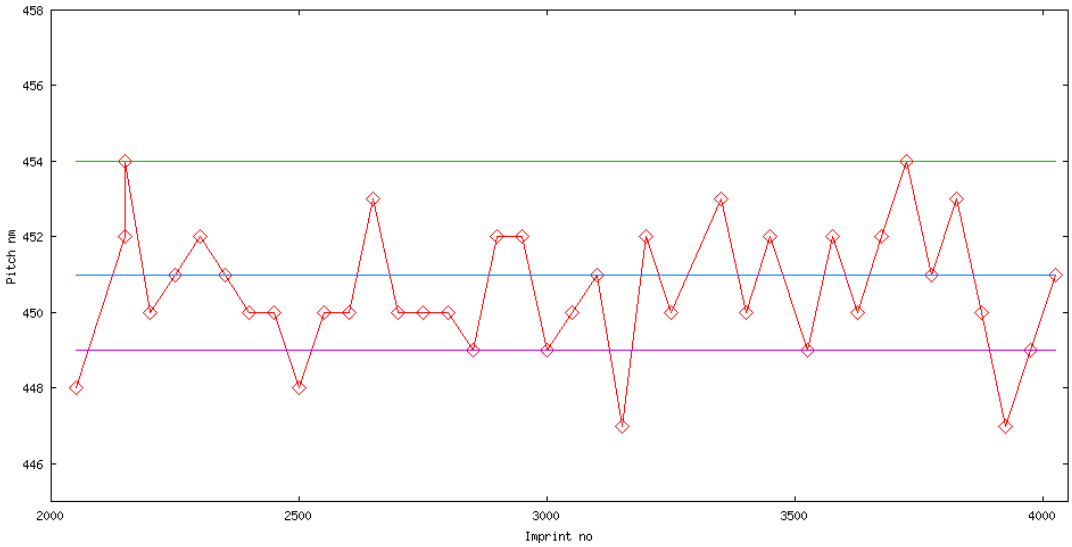

Fig. 2 The average pitch as a function of the number of imprints for imprint number 2000 - 4000. The red line with squares indicates the measured value of the pitch for the imprints whereas minimum, maximum and average values for the stamp are represented as lines.

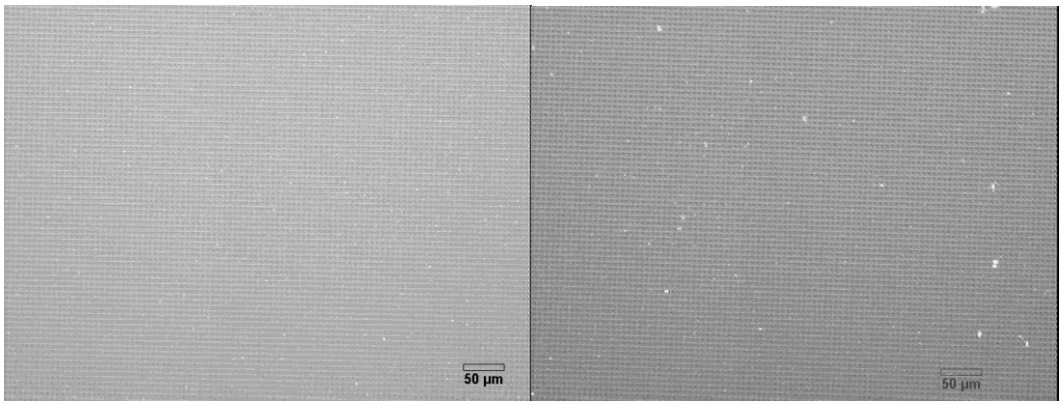

Fig 3. Dark field optical microscopy images showing the stamp before imprint (left) and after 8000 imprints (right).