# Matching material and process – The route to success for high-volume manufacturing of high-quality imprinted lenses

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The production of micro lenses or micro lens arrays (MLAs) via imprint and/or lens molding of UV curing polymers is a conceptual simple process. Difficulties start however when making the switch from lab-scale prototype production to truly high-volume production of high-quality optics at high yield.

In this field, tremendous progress has been made throughout the past years: Imprint materials have been improved in many ways (lower yellowing, better performance under harsh environmental testing, broader range of refractive indices, etc.) [1] and are now available at high quality and with stable supply worldwide. Imprint machines have made a big move from slightly modified mask aligners with all the associated limitations (e.g., low UV intensity) to dedicated imprint machines or even automated high volume cluster tools optimized for imprint applications with impressive features like precise alignment in the sub-µm range or handling capabilities for wafer size up to 300 mm.

However, it is obvious that working on the various aspects in an isolated way (resin supplier improving the resin, machine makers improving the machines, production companies improving the process) is not sufficient to bring wafer-level imprint of high-quality micro lenses to high-volume manufacturing.

Here we report on the joint efforts of DELO and EVG to demonstrate reliable production of micro lenses on a 200 mm wafer with focus on high (optical grade) surface quality and highest possible shape accuracy. By utilizing a matching combination of stamp and imprint material combined with an optimized process flow, the master lens structure could be replicated with minimal offset and at constant high quality, starting from the very first imprint.

Yet another aspect when trying to bring imprinted lenses into a real-world product is that you are not at all done after you successfully imprinted high-quality lenses at high yield. Many additional process steps would follow, like for example testing, dicing, assembly, etc. Here we report on the aspect of applying a nanostructured anti-reflective coating using the AR-plas2 process [2, 3, 4] developed at Fraunhofer IOF.

Reference:

[1] M. Brehm, C. Ertl, I. Pilottek and P. Heissler, "UV curing materials for wafer level optics" Advanced Fabrication Technologies for Micro/Nano Optics and PhotonicsXIII SPIE, Vol. 11292, pp. 42-49, 2022.

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[3] U. Schulz, P. Munzert, R. Leitel, I. Wendling, N. Kaiser and A. Tünnermann, "Antireflection of transparent polymers by advanced plasma etching procedures" Opt. Express, Vol. 15, pp. 1308-13011, 2007.

[4] U. Schulz, F. Rickelt, P. Munzert and N. Kaiser, "A double nanostructure for wide-angle antireflection on optical polymers" Optical Materials Express, Vol. 4, Nr. 3, pp. 568-574, 2014.