Polymer Injection Molding of Advanced Optical Nanostructures

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Abstract

As the applications for complex optical elements constantly increase and get more advanced, there is need for production of those in high volumes at low cost and on advanced free-form geometries. We present a solution for making advanced optical nanostructures such as anti-reflective patterns and diffractive optical elements (DOE) on steel mold inserts.

Moth-eye patterns for instance, are frequently used for their anti-reflective properties because their sub-wavelength size gives the effect of a refractive index gradient on the surface, which reduces reflections. We here present the replication of such antireflective structures onto a steel mold insert with a free-form surface. The free-form surface is required in order to yield 150 µm diameter lenses on a complex shaped molded part, which is to be used for coupling NIR light. The anti-reflective properties of the part are essential for reducing signal loss.

A wide range of molding conditions were tested in order to yield parts with optimal pattern fidelity. Furthermore, we investigated the stability of the anti-reflective structures on the mold surface which are exposed to harsh pressure and temperature conditions.

Figure 1: Mold insert with blow-up of the free-form cavity.

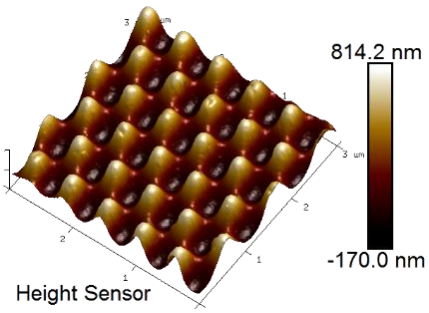

Figure 2: 3D representation of the anti-reflective surface on the mold insert, measured with tapping mode AFM (3 × 3 µm).

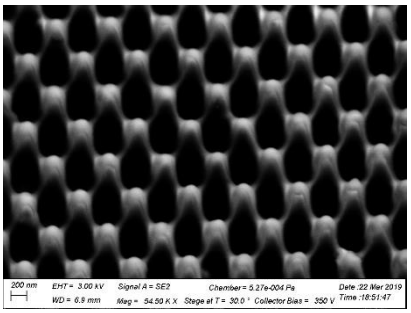

Figure 3: SEM scan of the anti-reflective structure on the steel mold insert.