Micro injection moulding of components with non-planar nanostructured surfaces: a study of moulding and ejection behaviour

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Abstract

Injection moulding of sub-micron structures has been a topic of interest recently where surface patterning of moulded components can realise a range of useful physical responses such as optical effects, superhydrophibicity, anti-fouling behaviours and tribological properties. Historically, much research in this area has been performed on planar surfaces, due to the fact that many nano-scale surface structuring methods, such as lithography and direct write techniques can only produce planar structures. However, the advent of 5-axis laser ablation systems allows comparitively low cost true 3D surface patterning of metals at the sub-micron level with Laser-Induced Periodic Surface Structures (LIPSS).

Here a new instrumented mould tool and insert system is presented which can produce a range of patterned geometries with conical walls with different cone angles (flat, 15°, 30°, 45°) to evaluate replication and ejection behaviour. For such components, the ejection pull direction is not directly parallel with the surface normal which could cause damage to surface structures. In addition, LIPSS surfaces will exhibit high adhesion forces during ejection which can cause tearing and part deformation. We explore the nature of forces during replication, mould separation and ejection for a range of process conditions for PP and PC materials. In addition, the structure deformation for each of the draw angles is presented. The results provide useful guidelines for tooling design for 3D nanotexture replication.

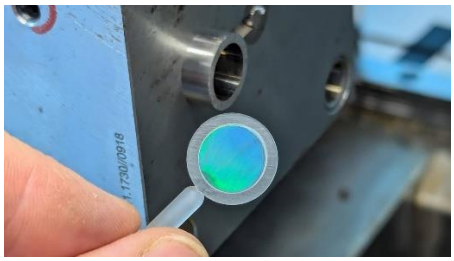

Figure 1: Mould tool; with nanostructured component