Nanostructured pattern replication on transparent polycarbonate by plastic injection

Jordi Fravedes, Daniel Ruso, Francesc Perez-Murano, Carles Colominas and Andrés García-Granada

Introduction

Micrometer-sized motifs have been patterned by focused ion beam (FIB) on diamond-like carbon (DLC)-coated stainless steel mould surfaces and replicated to surfaces of polycarbonate (PC) pieces by plastic injection.

Knowing the mechanical properties of workpieces and machine-tools at the nanometre scale is an absolute necessity for efficient nanoscale production. Current technologies are lacking the flexibility and robustness needed for measuring in a traceable way such key parameters as topography, morphology, roughness, adhesion, or micro- and nano-hardness in a production environment. The project aim4np strives at solving this problem for nano-roughness measurements by combining atomic force microscopy and white-light interferometry with novel control techniques from mechatronics and procedures from traceable metrology. The basic concept is to constantly measure and actively stabilize the distance between the surface of the workpiece and the mounting/reference base of the metrology heads, leading to an artificially stiff link between the two parts, which allows measuring the topography of the workpiece with nanometre resolution.

Plastic Injection of Polycarbonate

Fig.1. (a) DLC-coated parts of the mould, (b) SEM and (c) AFM images of the surface of the coating and (d) FIB cross section of the DLC coating on a steel mould. The overall coating thickness is 3.1 μm consisting of a gradient C-N-C adhesion multilayer and a 1 μm thick amorphous carbon layer with a hydrogen content of ca. 18 %.

Fig.2. (a) Scanning Electron Microscopy image of the FIB patterns prepared on a DLC-coated mould. The overall coating thickness was 3.1 μm consisting of a gradient C-N-C adhesion multilayer and a 1 μm thick amorphous carbon layer with a hydrogen content of ca. 18 %. AFM images of (a) a cross patterned on the mould end (c) the transferred cross to the PC injected piece.

Conclusions

- Plastic Injection is suitable for the patterning of micrometer- and nanometer-sized features
- Surface roughness of injected parts is lower than that of the injection mould under the used experimental conditions

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