Micro-texturation de surface de pièces polymères injectées à partir de la structuration submicronique du moule

Abstract

Over the past decades, industrial and academic research groups have been trying to functionalize surfaces, i.e. provide new properties to surfaces, in order to obtain specific functions such as friction reduction, anti-fog or de-icing properties. Among the various existing surface treatment techniques, laser ablation using an ultra-short pulse laser gives the opportunity to generate submicronic textures, which play an essential role in their functional behavior. However, in the case of mass production of textured surfaces, it is preferable to reproduce these textures with a fingerprinting technique for reasons of cost-effectiveness.

This work focuses on the study of the various factors involved in the replication of submicronic topographies by plastic injection. Understanding the influence of the parameters of the injection process, the properties of the injected polymer and the surface chemistry of the mold (with or without coating) is key to controlling the quality of the injected part.

A first study was carried out on two polypropylenes of different viscosities under low shear rate (MFR grade). A first step was to develop a methodology enabling to quantify the quality of replication of periodic and random submicron structures between the injected part and the mold. For identical injection parameters, it was observed that the quality of replication of the patterns on the injected parts was different when viscosity changed. A study of the structural and rheological characteristics of the polymers was carried out. This difference in replication was not due to their viscosity under the injection conditions in spite of very different MFR grades but to their mode of stress relaxation during the cooling phase [1].

A second study focused on the influence of the surface chemistry of molds when filling the cavities in the injection process. We mainly studied the phenomenon of adhesion of a molten polymer on different chromium nitride, titanium-based and DLC films deposited on mold substrates. From the temperature wetting tests and the surface energy measurements of the molten polymers, we determined the work of adhesion between the polymers and the coated or non-coated molds at injection temperatures [2].

On the basis of these results, we performed a synthesis work by developing a statistical approach based on the analysis of experimental plans in order to quantify the influence of various factors, both process (injection rates, Impression, mold temperature, etc.) and material (different polymers, different coatings on the mold) related. We showed that thermal exchanges at the mold-polymer interface had a dominant role in the quality of replication. In particular, these exchanges depend on the nature of the coatings and regulates the formation of the solid sheath during microinjection [3].

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[3] J. Vera, A.-C. Brulez, E. Contraires, M. Larochette, N. Trannoy-Orban, M. Pignon, C. Mauclair, S. Valette, S. Benayoun, Factors influencing micro-injection quality, Journal of Micromechanics and Microengineering. (soumis en juin 2017).