Processi, prodotti e servizi
Processes, products and sercice

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Main research topics:
- Manufacturing systems and processes
- Micro-technologies and precision technologies
- Shaping of metallic materials
- Processing of polymeric materials

Geometric metrology

Effects of different mold coatings on polymer filling flow in thin-wall injection molding

Computer, communication, consumer electronics and packaging industries are increasingly demanding lighter and thinner parts due to economic and environmental reasons. In fact, a reduction of the main wall thickness generally leads to a smaller part volume and, therefore, to a lower material cost and impact. A thinner wall also results in a shorter cycle time, decreasing the process environmental and economical burdens. Injection molding of parts having high flow length/thickness ratio is a challenging task for both micro and packaging applications. Therefore, in this work, the effects of three cavity surface coatings, viz. aluminum oxide, diamond-like carbon and silicon oxide, on the filling flow of polyethylene terephthalate (PET) and polystyrene (PS) were experimentally investigated. The filling of a representative micro-part was studied as a function of mold coating, injected polymer and different process parameters, in order to identify the effects of heat conduction and wall slip related to the coatings. A numerical model of the process was calibrated by inverse analysis to identify the thermal boundary conditions that characterize each coating in relation to the filling pressure. The experimental results indicated that all the coatings could be effectively exploited to reduce the cavity pressure, up to 8% for PET and up to 3% for PS. The experiments also gave some insight into the influence of the process parameters. In particular, for PET the lower value of melt temperature attenuated the coatings effect. Experimental and numerical results clearly indicate that the investigated mold coatings can be effectively exploited to reduce the filling pressure of PET, aiding the complete replication of the mold geometry. In particular, SiOx is more effective in lowering the HTC at low shear rates while Al2O3 promotes the wall slip at the interface at high shear rates.

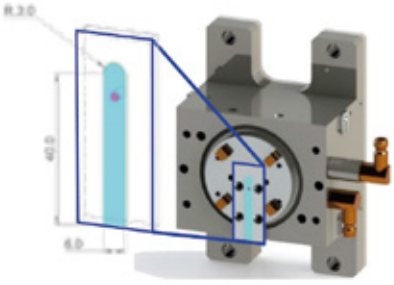

Figure 1. Design of the mold used for the experiments. The cavity is an open flow micro channel characterized by a length of 40 mm, a width of 6 mm and two alternative thickness value of 400 and 800 μm.

Figure 2. Different mold inserts with different coatings. From the left to the right: uncoated mold insert, ALD coating, DLC coating and SiOx coating.