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Quantification of the ejection force during injection moulding when applying different surface pretreatments, wear-resistant coatings, ion implantation and plastic types

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Plastic injection moulding of high-precision plastic components with high output volumes, using low cycle times without compromising on a high product quality and still keeping zero tolerance towards failures, is extremely important to increase both the productivity and keeping a competitive edge. At the same time, many moulds are becoming more and more complicated and costly. Hence, it is important to increase the lifetime, the wear resistance and the performance of the applied moulds.
The ejection force has been quantified in situ in an injection moulding process by incorporating a force sensor. The developed method was found to be so reliable that it was possible to measure a difference between 'as machined' moulds implying that each mould was used as its own reference. The model mould was designed to mimic the injection moulding of a real medical device.
The impact on the ejection force when adding different surface pretreatments to the injection moulding core ('as machined', grinded, blasted and laser textured) in combination with different PVD coatings (CrN, HiPIMS CrN, low-temperature pulsed TiAlN) combined with post treatment involving high-current implantation of nitrogen or oxygen has been investigated.
The ejection force was measured for four industrial relevant plastic types (ABS, PP, POM, TPU) before and after adding the wear-resistant coating as well as after ion implantion. The results revealed that the ejection force could be lowered by close to 70% for some of the plastic types by adding a combination of wear-resistant coating and ion implantation. These findings will be compared with empirical results from industrial-scale injection mouldings.
Nanoscale characterization of the applied coatings will be adressed based on nanoindentation, SEM and RBS.

Keywords
Ejection force
Injection moulding
PVD, HiPIMS