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The microstructure of N-ion-implanted CrN coatings and the relation to the slip properties in plastic injection moulding

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In the plastic injection moulding industry it is well-known that by using N^+ -ion-implanted CrN coatings on the moulds, a significant process improvement is achieved (for certain plastic types) compared to both uncoated moulds and moulds coated with CrN without ion implantation. In certain cases, ion implantation is critical to make the moulding possible at all.
This study investigates the changes in the microstructure of N^+-ion-implanted CrN coatings compared to an unimplanted CrN sample. The aim is to explain the impact of N^+ on the improved demoulding properties. The ejection force in the moulding process is quantified for both types of coatings using industrially relevant test moulds and different plastic types.
The CrN coatings are deposited on Si wafer and on test moulds using a CemeCon CC800 unit. Ion implantation on a subset of samples is done in a Danfysik ion implanter. An RBS analysis shows that additional N^+-ions are indeed present in the implanted coating and that the depth profile corresponds to the used energy and dose. Nanoindentation measurements reveal that implanted samples are harder than the CrN reference (21 GPa versus 18 GPa), which is similar to other observations in the literature.
Coatings are analysed with different experimental techniques (XRD, XPS and TEM) to obtain information about their microstructure including chemical composition and lattice structure. Measurements of the ejection force are done using the coated test moulds for several plastic types (PP, ABS, POM, TPU and PPA). These measurements show that lower values of the ejection force are obtained for CrN-coated moulds than for the uncoated CrN reference and that ion implantation further lowers the demoulding force in the case of PP, ABS and TPU. For POM, ion implantation does not lower the ejection force and for PPA, an increase in the force is observed.

Keywords
CrN coatings
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Plastic injection moulding
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