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Laser surface modification of CrVN coatings for self-lubricating performance

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Hot forming, especially hot forging is a very demanding forming application requiring tool material with high strength and toughness and above all good wear resistance at elevated temperatures. Prevailing wear mechanisms in hot forming are abrasive wear and galling, with abrasive wear leading to dimensions mismatch and galling to unstable friction and poor surface quality of the forgings. In order to reduce tool wear and improve forming process different wear resistant coatings like CrN are used. However, relatively high coefficient of friction of CrN coatings against soft metals hinders their applicability, still requiring the use of different lubricants in the most demanding applications. Vanadium nitride (VN), on the other hand has attracted increasing interest as VN is easily oxidized to form Magneli phase vanadium oxides with easy slipping shear planes, leading to self-lubricating properties.
Therefore, the aim of our work was to study the effect of V content and laser surface modification of CrVN coatings on triblogical properties and formation of self-lubricating tribofilms. CrN coatings doped with V in concentrations from 15 to 30 % were deposited by industrial DC-magnetron sputtering system and further surface modified with IPG Fiber laser using different laser power and scanning speed. The aim of laser surface modification was to induce formation of lubricious oxides on the coating's surface. Surface modified CrVN coatings were then tested on load-scanner and under reciprocating sliding conditions. Tribological testing of CrVN coatings with different V content was performed at room and elevated temperatures (up to 600℃) against typical structural steel and Al alloy for hot forging and results evaluated in terms of coefficient of friction, wear volume, critical load for galling initiation and wear track surface analysis. Surface analysis was focused on the formation of self-lubricating oxides and tribofilms.

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