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A comparison of the galling wear behaviour of PVD Cr and electroplated hard Cr thin films

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Abstract

Electroplated hard chromium (EPHC) is used in many industries as a wear and corrosion resistant coating. However, the long term viability of the electroplating process is at risk due to legislation regarding the toxic chemicals used. The physical vapour deposition (PVD) process has been shown to produce chromium and chromium-based coatings that could be a possible alternative for EPHC in some applications. This study investigates the microstructure and properties of two PVD chromium coatings as a possible alternative to EPHC to provide resistance to galling. Two PVD deposition processes are investigated, namely electron beam PVD (EBPVD) and unbalanced magnetron sputtering (UMS). Galling wear tests were performed according to ASTM G98-17. The results show that the two PVD coatings are of similar hardness, surface roughness and exhibit similar scratch behaviour. However, the galling wear resistance of the coating deposited by UMS is approximately ten times that of the EBPVD coating, and similar to that of the EPHC. X-ray diffraction reveals that the EBPVD chromium coating has a strong preferred orientation of the {2 0 0} planes parallel to the coating surface whilst in the UMS PVD coating, preferred orientations of the {1 1 0} and {2 1 1} planes parallel to the surface are observed. The EPHC does not exhibit relative peak intensities which conform to the International Centre for Diffraction Data (ICDD) powder diffraction pattern consistent with chromium. The crystal orientation of the PVD chromium coatings appears to play a significant role in influencing galling resistance.

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