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Influence of Morphology and Coatings in the Tribological Behavior of a Texturised Deterministic Surface by Photochemical Machining

Authors : Juan C. Sanchez, Jose L. Endrino, Alejandro Toro, Hugo A. Estupinan, Glenn Leighton

Abstract : For years, the reduction of friction and wear has been a matter of interest in the engineering field. Several solutions have been proposed to address this issue, including the use of lubricants and coatings to reduce the frictional forces and to increase the surface wear resistance. Alternatively, texturing processes have been used in a wide variety of materials, in many cases inspired in natural surfaces. Nature has shown how species adapt to the environment and the engineers try to understand natural surfaces for particular applications by analyzing outstanding species such as gecko for high adhesion, lotus leaves for hydrophobicity, sharks for reduced flow resistance and snakes for optimized frictional response. Texturized surfaces have shown a superior performance in terms of the frictional response in many situations, and the control of its behavior greatly depends on the manufacturing process. The focus of this work is to evaluate the tribological behavior of AISI 52100 steel samples texturized by Photochemical Machining (PCM). The surface texture was inspired by several features of the snakeskin such as aspect ratio of fibrils and mean fibril spacing. Two coatings were applied on the texturized surface, namely Diamond-like Carbon (DLC) and Molybdenum Disulphide (MoS_2), and their tribological behavior after pin-on-disk tests were compared with that of the non-texturized and uncovered surfaces. The samples were characterised through Stereoscopic Microscope (SM), Scanning Electron Microscope (SEM), Optical Microscope (OM), Profilometer, Raman Spectrometer (RS) and X-Ray Diffractometer (XRD). The Coefficient of Friction (COF) measured in pin-on-disk tests showed correlations with the sliding direction (relative to the texture features) and the aspect ratio of the texture features. Regarding the coated surfaces, the DLC and MoS_2 coating had a good performance in terms of wear rate and coefficient of friction compared with the uncoated and non-texturized surfaces. On the other hand, for the uncoated surfaces, the texture showed an influence in the tribological performance with respect to the non-texturized surface.

Keywords : coating, coefficient of friction, deterministic surface, photochemical machining
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