Tribological Behavior of DLC Coatings on AISI 4340 Steel Deposited in PECVD DC-Pulsed Technique with Additional Cathode for Automotive Applications

Ramirez. M.A, Fukumasu. N.K, Lugo D.C, Mitma P.E, Machado. I.F, Trava-Airoldi. V.J

Abstract

Diamond-Like Carbon (DLC) coatings have attracted significant attention due to its low friction, high hardness, high wear resistance, among others. These films meet conditions that can be used in some mechanical applications in aerospace and automotive industries. The major disadvantage of these coatings is the low adhesion on metallic substrates, caused by elevated compressive residual stresses after deposition. Some plasma conventional methods require a high consumption of energy that are used to grow DLC films, resulting in a high level of temperature and pressure during the deposition, which affects the adhesion of the film to the substrate. The use of PECVD-DC Pulsed with additional cathode, allows to grow DLC films in extremely low pressure and temperature. In this work, DLC coatings were deposited employing an asymmetrical bipolar pulsed-DC PECVD with additional cathode at temperature as low as 90 C and pressure as low as 0.1 Pa, which allowed a collisionless regime and a higher plasma density. Acetylene gas was used as a precursor. In order to overcome low adhesion of DLC films on steel substrate, a thin amorphous silicon interlayer was deposited as an interface. Resulting coatings were analised with SEM-FEG and Raman scattering spectroscopy in terms of morphology and atomic arrangement,respectively. The total residual stress was evaluated by the curvature method. The tribological behavior (friction and wear) was analyzed by reciprocating wear tests at room temperature. Adhesion was evaluated in accordance with the VDI3198 norm, based on a Rockwell C indentation test. XPS analyses, will also be used in order to get a relationship among the adhesion and the silicon interface on set nucleation parameters. The elevated coating hardness (higher than 25 GPa) promoted good wear resistance. These results suggest that the PECVD-DC Pulsed with additional cathode and acetylene as a precursor gas to grow DLC films on engineering steels may represent a new alternative to improve the mechanical behavior in automotive applications.