OR1407

Characterization of metal doped a-C:H coatings after unlubricated wear tests

Cedric JAOUL[1], Maggy Colas[1], Laureline Kilman[1], Christophe Le Niniven[1], Etienne Laborde[1], Frédéric Meunier[2], Pascal Tristant[1]

[1]University of Limoges - SPCTS, Limoges, France [2]Oerlikon France, Limoges, France

jaoul@ensil.unilim.fr

Among the diamond-like carbon (DLC) coatings, hydrogenated amorphous carbon (a-C:H) possess good tribological properties with a low friction coefficient (typically inferior to 0.25 against unlubricated steel counterpart) and a low wear rate (typically inferior to 0.01 10^{-6} $mm^3/N.m$). Nevertheless, very large compressive stress are included in these films that limit their thickness in order to keep a good adhesion on the substrate, even in presence of interlayer. Many metallic elements have been introduced in a-C:H coatings in order to reduce of the internal stresses or to improve toughness. The resulting material is generally a nanocomposite with metal-rich nanoparticles embedded in the hydrogenated amorphous carbon matrix. Some metals like Nb or Mo exhibit a strong bond with the carbon and while some others metals like Al or Cu are called weak-carbide-forming due to their very low affinity with carbon. The purpose of this work is to compare the tribological properties of metal doped a-C:H coating with four different metallic element : Nb, Mo, Al and Cu. Coatings are deposited by a hybrid magnetron sputtering-PECVD process and the sputtering power is adapted for each dopant to obtain a “low” metal content in the film with $[M]/([C]+[M]) < 0.1$ in order to limit the drop in hardness, generally observed in the literature. Friction experiments are performed using an alternative ball-on-disk Plint TE77 tribometer with 100Cr6 steel balls of 6 mm diameter, under a normal load of 25 N in unlubricated conditions at ambient temperature and a controlled relative humidity. The results show that the metal insertion in the a-C:H lead to a reduction of the friction coefficient (except in the case of Cu) while wear rates are equivalent. At last, the wear behaviors of each film are interpreted thanks to the structural and chemical evolution of both surfaces (wear tracks and wear scars on the counterface) characterized by SEM, XPS and Raman spectroscopy.

Keywords
DLC
a-C:H:Me
Tribological properties
Raman spectroscopy