PECVD/PVD hybrid deposition technology for developing Ag- and Ti-reinforced hydrogenated amorphous carbon nanocomposite coatings

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Abstract: This study aims to develop nanoparticle reinforced thin films with improved properties introduced through the inclusion of metals (Ag or Ti) than the ones exhibited by the hydrogenated amorphous carbon (a-C:H) matrix itself. The research motivation is to obtain films with tailored characteristics and optimum mechanical performances, that is, low friction coefficient and high toughness and abrasion resistance. For effective reinforcement, the particles should be small, with controlled geometrical characteristics, and evenly distributed throughout the matrix. These characteristics have been achieved through the use of a hybrid deposition technology, a combination of Plasma Enhanced Chemical Vapor Deposition (PECVD) and Physical Vapor Deposition (PVD). The amorphous carbon matrix is generated by the PECVD through carbon ions generated by an RF Plasma source by cracking methane, while the metallic nanoparticles are generated through a nanoparticle source based on PVD technology. The density and hydrogen content for the a-C:H matrix as well as the metal particle sizes and composition can be controlled during deposition. The physical, chemical, morphological and mechanical characterization of the films were accomplished through XRR, Raman Spectroscopy, SEM, AFM and nanoindentation, respectively. It is found that both Ag and Ti nanoparticles promote scratch resistance for the a-C:H:Me nanocomposite films. However, the different reactivity of each metal with the matrix leads to different percentage for critical load to fracture. The ability to form nanocomposite structures with optimum coating performance by controlling the carbon bonds (sp3, sp2 or sp1), the hydrogen content, and the type and content percent of metallic nanoparticles opens new avenues for a broad range of applications were mechanical, physical and/or optical properties are required.