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Self-Assembled Multi-Layer a-C:H/Me Coatings by Reactive Sputter Deposition

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The growth and characteristics of metal containing amorphous hydrogenated carbon thin films (a-C:H/Me) were studied in this research. The formation of self-assembled, alternating nano-layered structures are addressed. a-C:H/Me thin films were synthesized using one single target, a rotating but not revolving substrate, and constant feed gas compositions in a conventional reactive sputter deposition chamber. The metals used include Al, Si, Cu, Pt, Fe and Ni. Various mixtures of methane and argon having fixed total flow rates were used as the feed stocks. A number of growth parameters, including methane concentration, working pressure, electrode distance, dc power, substrate bias, and substrate temperature were used. The resulting a-C:H/Me thin films were found to exhibit three different structures. Among them, self-assembled, alternating nano-layered structures were observed in a-C:H/Cu, a-C:H/Pt, a-C:H/Fe, and a-C:H/Ni thin films. It was found that such self-assembled, alternating nano-layered structures can be obtained under controlled growth parameters for selected metals. A growth mechanism based on the considerations of clustering of carbon and metal, segregation of carbon, catalytic effects of metal, formation of carbide, energy of adatoms, and surface diffusion of metal and carbon, has been developed. Further data analysis was also performed to verify the validity of the mechanism.