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Vapor-deposited metal-boride interfacial layers as diffusion barriers for nanostructured diamond growth on cobalt alloys

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The primary research objective is to investigate chemical vapor-deposited (CVD) metal-boride interfacial layers on CoCrMo alloy as a robust diffusion barrier to prevent chemical interaction of elemental cobalt with carbon, which would otherwise lead to graphite formation during subsequent Nanostructured diamond (NSD) growth. The NSD coating itself is inherently comprised of crystalline and amorphous components with both sp^3-and sp^2-carbon bonding, and can be made to exhibit high hardness (H=60-90% that of phase-pure diamond). We show that a body-centered tetragonal interfacial boride (Co2B) is created and provides an effective diffusion barrier to enable well-adhered NSD coatings on CoCrMo. Interestingly, migration of molybdenum is suppressed after boriding, and does not appear on the surface. Most boron is present as borides with very small contributions from boron nitrides and oxides. Chromium remains primarily in elemental form on the surface, but with minor amounts of chromium nitrides/oxides. Most importantly, elemental cobalt is not present on the surface as measured by glancing-angle x-ray diffraction. While pack boriding of steels is common (e.g. for machine tool applications), the structure and diffusion barrier properties of borided CoCrMo, especially made by CVD, is not well known. The experimental findings of this research will demonstrate that the primary adhesion obstacle for CVD diamond on CoCrMo can finally be overcome by creating robust metal-borides fully compatible with the CVD process and substrate. Potential applications include alternative total joint replacement wear couples utilizing nanostructured diamond (NSD) surfaces instead of conventional metal-on-metal or metal-on-polyethylene bearings.

Biography

Aaron Catledge received his Ph.D. in Materials Science from The University of Alabama at Birmingham (UAB) in 1999, where he continued postdoctoral studies and is now assistant Professor in Physics. His research career has focused primarily on nano-biotechnology as it applies to development of nanostructured diamond coatings for orthopaedic/dental implants, electrospun composite scaffolds for tissue regeneration, and nanodiamond fluorescence in biosensing. He has more than 55 peer-reviewed publications in the period from 2003-2013, which includes 3 book chapters as 1st author.

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