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Controlling structure and morphology of WC based thin films

Thomas Glechner[1], Alexander Kirnbauer[2], Christian Tomastik[3], Ewald Badisch[3], Peter Polcik[4], Paul Heinz Mayrhofer[2], Helmut Riedl[2]

[1]TU WIEN, Wien, Austria [2]Institute of Materials Science, TU Wien, Wien, Austria [3] AC2T research GmbH, Wiener Neustadt, Austria [4]Plansee Composite Materials GmbH, Lechbruck am See, Germany

thomas.glechner@tuwien.ac.at

Tungsten carbide coatings are used in various tribological applications such as interlayers for DLC based films or as abrasive protection coatings. The morphology of transition metal carbide based thin films synthesized via PVD methods ranges from crystalline to nanocomposite coatings as well as nano-clustered structures in amorphous films. In addition, for WC based coatings two competing phases, hex-W_2C and fcc-WC_x, strongly disturb a purely crystalline growth.
Therefore, this study aims for an understanding of the deposition parameters and hence obtained morphology and phases applying diverse target materials in reactive (C_2H_2+Ar) and non-reactive sputter processes. We compare a wide range of target types: metallic W, WC ceramic including a conventional cobalt binder, as well as binder-free WC ceramic targets (with or without graphitic carbon additions). We applied XRD, XPS, TEM, SEM and nanoindentation to investigate structure, composition, morphology, carbon bonding nature and mechanical properties. For an in depth understanding on the phase formation, we also applied atomistic modelling using DFT (Density Functional Theory). The addition of acetylene strongly triggers the formation of amorphous structures, but highly sensitive for each individual target type. Carbon concentration within the target as well as within the reactive atmospheres affects the carbon bonding nature observed by EELS and XPS. Furthermore, in non-reactive processes (using Ceramic targets) the phase formation and morphology can be adjusted by bias potential. This study therefore gives new insights and perspectives for this well-known thin film material.

Keywords
Tungsten Carbide
Reactive Sputtering
Ceramic Targets
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Graphite Addition