Materials Science & Engineering Seminar Series

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Superhard PVD Coating Materials – Fundamental Aspects During Film Growth and Challenges in Industrial Utilization

Priv.-Doz. Dr. Sven Ulrich
Karlsruhe Institute of Technology (KIT)
Institute for Applied Materials (IAM-AWP)

ABSTRACT:
Diamond like-carbon, cubic boron nitride, boron carbide and silicon carbide with compressive stress are promising materials for numerous applications due to their outstanding property profile. With its extreme hardness, excellent thermal conductivity, as well as chemical inertness at high temperatures, cubic boron nitride is, for example, superior to diamond as a protective coating of tools for use in various high-temperature and ferrous-metal machining. Coatings based on cubic boron nitride can be produced nowadays already by almost every physical vapor deposition or plasma enhanced chemical vapor deposition method. However, such coatings usually exhibit unacceptably high compressive residual stresses resulting from the intense yet obligatory ion bombardment during the nucleation and growth process and, therefore, are still inadequate for the anticipated applications. In recent years many concepts and techniques have been actively explored in attempt to reduce the undesired coating stress, such as incorporation of a third element e.g. hydrogen, carbon, oxygen or silicon in the cubic boron nitride system, reduction of ion energy after the cubic phase nucleation, post-deposition thermal annealing, high-energy ex-situ ion implantation, fluorine-based surface chemistry, and composition-graded bond layer for enhanced adhesion. Cubic boron nitride coatings are comprehensively compared with diamond-like, boron carbide and silicon carbide thin films. Different coating concepts and processes leading to low-stress and thick coatings, results of modeling, microstructure and properties in relation to the process parameters as well as the challenges in industrial up-scaling will be discussed.

BIOGRAPHY:

Priv.- Doz. Dr. Sven Ulrich is Deputy Head of the Institute for Applied Materials, Head of the Department Composite and Thin Films, and is a lecturer at the Faculty of Mechanical Engineering at the Karlsruhe Institute of Technology (KIT). He is an active member of the council board of the German Vacuum Society and of the advisory board of the Institute for Surface and Thin Film Analysis in Kaiserslautern, Germany. His research activities focus the understanding of plasma surface interactions during dynamic thin film growth processes on the atomic level and on the identification of mechanisms during the thin film growth itself. Furthermore, he investigates correlations between coating design, plasma conditions, film growth, microstructure, properties and coating behaviour which introduce into applications. He uses various reactive and non-reactive physical vapour deposition techniques as well as plasma assisted chemical vapour deposition methods for the development of protective and functional coatings, including materials for lithium ion batteries. He has published more than 120 papers and review articles. Additionally, he holds 46 patents.

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