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Nitin Patel
Graduate Research Assistant
Department of Materials Science and Engineering
Carnegie Mellon University

"Structure-Property Relationships of Nitride Superlattice Hard Coatings prepared by Pulsed Laser Deposition"

Friday, February 9, 2007
11:00 A.M. Seminar in Baker Hall 136A
Refreshments precede seminar at 10:30 A.M. in 2325 Wean Hall

Today, more than 40% of all cutting tools used in machining applications are covered with coatings. Coatings improve wear resistance, increase tool life, enable use at higher speed, and broaden the application range. Superlattices, where thin layers (typically < 10 nm) of two different materials (e.g. TiN and AlN) are deposited in an alternating fashion, are widely used commercially. Importantly, the hardness value of a superlattice (e.g. TiN/AlN) can significantly exceed the rule of mixture value. Superlattice coatings built from crystallographically dissimilar materials are not widely studied but hold promise for improvements in performance by allowing for both hardness and toughness to be simultaneously optimized. A structure-property comparison of isostructural superlattices with corresponding non-isostructural superlattices is the focus of our work. Towards this end, the synthesis of different phases of AlN, (Ti,Al)N, TaN, and TiN was investigated. Films were grown by pulsed laser deposition in two different chambers that had different base pressures. AlN and (Ti,Al)N films partially oxidized in a chamber that had a base pressure of 10^{-5} Torr, but adopted their stable nitride structures in a chamber with the lower base pressure of 10^{-7} Torr. TaN adopts either the cubic rocksalt structure or its stable hexagonal structure, depending on the growth temperature, while TiN grows as rock-salt in all conditions. Single crystal epitaxial superlattices were then grown with different compositions, periodicities, and crystallographic orientations to compare the effect of chemistry, nanostructure, and crystallographic texture on hardness. Finally, the structure-property relationships of non-isostructural (cubic/hexagonal) superlattices will be presented as compared with that of the corresponding (111) isostructural cubic superlattices. Nanoindentation measurements revealed similar hardness values for the non-isostructural superlattices as compared to the isostructural coatings deposited under identical conditions.

Nitin received his undergraduate degree in Chemistry from Indian Institute of Technology, Kanpur in 1999. He then obtained his Masters degree in Chemistry from Carnegie Mellon University in 2001. He is currently a Ph.D. candidate under the guidance of Prof. Salvador.