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Tutorial #3

Fundamentals of sputter deposition; control of microstructure evolution

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This module will elucidate the fundamental processes during sputter deposition: sputtering at the target, discharge maintenance, transport in the gas phase and film nucleation and growth on the substrates. We will reveal mechanisms to manipulate microstructure evolution by low-energy metal and gas ion fluxes in order to achieve high-quality films at low deposition temperatures.

Topics include:

- Introduction to Sputter Deposition; Important processes to consider:
- Elements of kinetic theory of gases and plasma physics
- Discharge maintenance
- Sputtering yield, Sputtering systems
- Film growth processes—nucleation, coalescence, competitive grain growth, recrystallization
- Zone diagrams, Effects of reactive species.
- Kinetic roughing and surface facet formation
- Texture inheritance
- Metal-ion etch and adhesion control
- Control of microstructure evolution during sputter-deposition
 - Effects of sputtered atoms energy
 - Effects of gas ion energy
 - Use of high fluxes of low-energy gas ions
 - HiPIMS as a source of energetic metal ions
 - Metal-ion assisted growth – dense, stress-free films

About the lecturer

Ivan Petrov is a Principal Research Scientist at the Materials Research Laboratory (1998-present), Professor of Materials Science, and 1998-2010, Director of the Center for Microanalysis of Materials at the University of Illinois at Urbana-Champaign. He is an Asjunct Professor of Physics at Linköping University, Sweden (2010-present) and has served as Visiting Professor of Surface Engineering at Sheffield Hallam University, U.K. (2000-2012). His research interests include nanostructural and nanochemical analyses, thin film physics, and surface science. He has published 350 refereed papers cited 27000 times with H-index of 84. His review article on microstructural evolution of thin films has > 2300 citations. Ivan served as AVS president in 2025 and IUVSTA Surface Engineering Division Chair during 2007-2022. Ivan is an Editor of the journal *Surface and Coatings Technology*.

