

Thursday, March 5, 2009 4:00 pm in Room 303 MAE-A

## Controlling atomistic processes to develop tailored surfaces for engineering studies

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### Abstract

Plasma processing of materials is a means to achieve exquisite control of the atomic structure and composition of surfaces. This level of control is the result of the unique parameter space attainable in the plasma environment, where relative densities of ionized chemical species produced by charged particle impacts are accelerated by electrostatic potentials into surfaces (i.e., substrates) immersed in the plasma. Unfortunately, the collective behavior associated with plasmas, where those electrostatic potentials and fluxes of ionized species are closely related, makes the contribution of these intrinsic plasma characteristics to surface phenomena difficult to discern. To isolate the effect of individual process parameters, experiments were conducted to vary the flux or kinetic energy of a particular atom or ion independently, while maintaining all other conditions constant, to evaluate the contribution of that parameter to surface kinetics. Such experiments serve to validate models of film growth mechanisms and plasma-based diffusion treatments of materials, but also permit unparalleled capability for controlled variation of physical properties of surfaces for diverse engineering applications. For example, films comprised of highly anisotropic crystalline compounds, such as transition metal dichalcogenides (e.g., MoS<sub>2</sub> and WSe<sub>2</sub>), can be altered to consist of crystals with their basal planes oriented either parallel or perpendicular to the surface. The degree of crystal orientation dictates physical properties of the film materials, such as their surface energy and thermal conductivity, which have been shown to vary with orientation by orders of magnitude for films with the same composition and microstructure. Metal-ceramic, polymer-ceramic, and other types of nanocomposite coatings for adaptive tribological and flexible optical coating applications have also been developed using hybrid plasma deposition techniques to modulate the size and distribution of features and inclusions within composite matrices. Furthermore, novel processing techniques to decouple the growth kinetics of separate phases have facilitated incorporation of nanoscopic entities such as nanotubes, nanoparticles, and protein molecules into thin film composites or nanolaminate coating materials for use in thermoelectric and sensor material development.

### Biography

Christopher Muratore received his Ph.D. in Materials Science and Engineering from the Colorado School of Mines in 2002. Upon completion of his degree, he was an American Society for Engineering Education Postdoctoral Research Fellow in the Plasma Physics Division of the Naval Research Laboratory, where he characterized and developed novel plasma processing techniques for manipulating engineering surfaces. He was recognized for his efforts at NRL with the American Vacuum Society Bunshah Award in 2004. He joined the Air Force Research Laboratory in 2004, and is currently the Lead Scientist of the Thermal Sciences and Materials Plasma Processing Facility.

*Refreshments served in 303 MAE-A beginning at 3:50 pm*

