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Intentionally Patterned and Spatially Non-Uniform Profiles in Thin-Film Deposition Systems

by

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In thin-film manufacturing processes such as Chemical Vapor Deposition (CVD), one typically strives for uniform film properties (thickness, microstructure, composition, etc.) across the substrate (wafer). In some cases, however, it is desirable to control deposition rate or a film property profile to a specific, spatially non-uniform distribution; such situations arise

1. in single-wafer combinatorial processing where the objective is to deposit a film with properties that vary as a function of location on the wafer;

2. as a result of the intrinsic non-uniformity of the deposition rate profile in cross- and radial-flow reactor systems, where simple or planetary wafer rotation arrangements are used to improve uniformity.

In both of the deposition reactor systems discussed, we see the need to 1) identify the desired spatial deposition profile and 2) control the gas phase spatial composition to achieve the target profile.

The computational methods and reactor design features necessary to accomplish these goals are the focus of this talk. Numerical tools developed by our research group in close collaboration with industrial partners include a full-wafer response-surface modeling methodology applicable to the optimization and control of film properties across the entire substrate, and a modular simulation framework that simplifies development of the multiscale models describing these manufacturing processes. The equipment design and simulator development issues will be presented in the context of microelectronic and solar energy device manufacturing applications.

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