A MULTILENGTH SCALE APPROACH TO MATERIALS USING STOCHASTIC AND COMPUTATIONAL STATISTICS TECHNIQUES[1]

Nicholas Zabaras
Materials Process Design and Control Laboratory
Sibley School of Mechanical and Aerospace Engineering
188 Frank H T Rhodes Hall
Cornell University
Ithaca, NY 14853-3801

A brief review will be provided of the potential benefits of using stochastic modeling, Bayesian inference, spatial statistics and statistical (machine) learning techniques in a multi-length scale approach to the analysis and robust design of continuum systems with applications in fluid/solid mechanics and materials science.

A number of specific examples will be highlighted including the following:

- Development of a stochastic variational multiscale (VMS) approach for fluid flow in the presence of input uncertainties with subgrid scale (SGS) modeling using the spectral stochastic finite element method (SSFEM), generalized polynomial chaos, Karhunen-Loève expansion techniques and a support-space approach.
- Bayesian inference for stochastic upscaling for convection processes in porous media using an inverse approach.
- Using machine learning techniques for a materials-by-design approach to polycrystal materials. We will demonstrate the importance of these techniques for reduced-order representation of microstructures, for exploring the synergies between material properties, material processes and microstructures and for designing materials with desired microstructure-sensitive properties.

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