

# A microstructure-sensitive design approach for controlling properties of HCP materials<sup>1</sup>

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A model reduction technique based on the proper orthogonal decomposition method is presented for modeling the microstructure evolution of HCP polycrystals including slip and twinning. The polycrystal is represented by an orientation distribution function using the Rodrigues parameterization. This model can be used for representation and fast exploration of process/structure/property relations in HCP polycrystals. Using this model, a number of microstructure-sensitive deformation design problems are addressed for the control of texture-dependent properties. A continuum sensitivity-based gradient optimization framework is introduced for computing the variability of the microstructure evolution induced by perturbations on the macroscale velocity gradient. Design of both single and multiple stage processes is considered. Finally, integration of the material point design simulator with a multiscale design framework will be shown demonstrating the design of macro-process parameters for the control of microstructure-sensitive properties.

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