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ABSTRACT

Material behaviors, especially their plastic responses, are driven by the material's initial texture and how it evolves [1]. Transmission electron microscopy (TEM) investigation and electron backscatter diffraction (EBSD) analysis are often used to study polycrystalline material textures through pole figure illustrations. However, with the development of new manufacturing processes, like additive manufacturing, and to better understand material response at different scales, the storage volume of experimental data, like crystallographic observations (ODF files), is growing fast. There is a need to improve the way to treat these data. In the context of reduced-order modeling for microstructure representation, Proper Orthogonal Decomposition (POD) is a powerful tool to treat high-dimensional data and extract its intrinsic dimensionality [2]. We present, in this study, a novel application of POD to represent polycrystalline textures. Using POD on a collection of textures at different steps of a mechanical test, like a tensile test, we can extract the low-dimensional basis that captures the dominant modes of variation in the data. This basis can then be used to obtain an admissible material's random texture and significantly reduce the problem's dimensionality for the same test. As ODF files generally quantify the orientation of all the crystals of a specimen using Euler angles, POD has to be performed on periodic data. We will illustrate the specificity of Linear Algebra operations on periodic data, first using simple cases, then using synthetic ODF files. This work is part of a broader effort to apply a model-order reduction in homogenization and multiscale data-driven simulation. The goal is to account for experimental polycrystalline texture information in simulation and design.

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