Process-structure linkage for static recrystallization of cubic materials

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Abstract: Static recrystallization is widely used in industrial processes to soften embrittled cold worked material as well as previously hardening materials. Static recrystallization is also a means of controlling the microstructure of the final component. The modeling of this process is difficult due to various obstacles such as the adequate inclusion of microstructural features to fully quantify the microstructure. In the current study, novel microstructure characterization techniques by spatial statistics via real symmetric GSH basis functions are employed to characterize the microstructures with high fidelity. However, such characterization methods inherit their own set of issues including the generation of a dense feature space per microstructure. This leads to leveraging dimensionality reduction techniques (kernel PCA) in order to establish an augmented feature space to build models. Finally, the process of recrystallization is a history dependent process. Naturally, this lead to the modeling of a nonstationary process. By leveraging Time Series Multivariate Adaptive Regression Splines (TSMARS) and autoregressive integrated moving average (ARIMA) models a process-structure linkage for the physical process of recrystallization is built which establishes the first linkage in the process-structure-property chain.