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A coupled curvature-driven mechanism for both 2D and 3D simulation for high temperature austenite grain growth based on cellular automata

Min Wang; Jianxin Zhou; Yajun Yin; Hai Nan; Wen Li; Tong Wang; Dongqiao Zhang, Huazhong University of Science and Technology

ABSTRACT

Based on the thermal activation theory and curvature-driven mechanism, a 2D and 3D cellular automaton model with different state transition rules was built according to previous cellular automata models. The validity of the model was proved by the shrinking of circular grains in 2D situation. Grain growth of high temperature austenite was simulated by this model in both 2D and 3D situations, microstructure evolution and the kinetics curves of the grain growth were obtained, and moreover, the grain growth processes were investigated for different temperatures and different activation energy, respectively. Important phenomena of curvature-driven grain growth have been analyzed, including growth kinetics, grain size distribution, and the time invariance of the grain size. The results indicate that the grain growth of high temperature austenite is a process of big grain consuming small ones. The growth exponent calculated by this model at different temperature is a little smaller than the theoretical value 0.5, but the calculated values are in good agreements with the experimental results done by other researcher. Evolution of grains with different edges has been tracked in both 2D and 3D situations; simulation results of both the 2D and 3D situations have shown a good agreement with Mullins equation.

KEYWORDS: cellular automata, curvature-driven, grain growth, 2D and 3D simulation