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In this talk we will provide a brief overview of recent advances in mathematical modeling of grain growth. In particular, we will focus on vertex models and their use in studying nucleation of three-sided grains by means of the stored energy formalism. Analytical results concerning stability of a triple junction motion and energy dissipation during nucleation will be discussed. We will also provide a brief overview of a GPU-based parallelization strategy for managing grain boundary flippings. (Received September 25, 2018)