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Research interests:
Phase transformations,
Heat treatments,
Metals and alloys,
Modelling and simulations

Modelling austenite decomposition: bainite, acicular ferrite, heat of transformation and effect of deformation

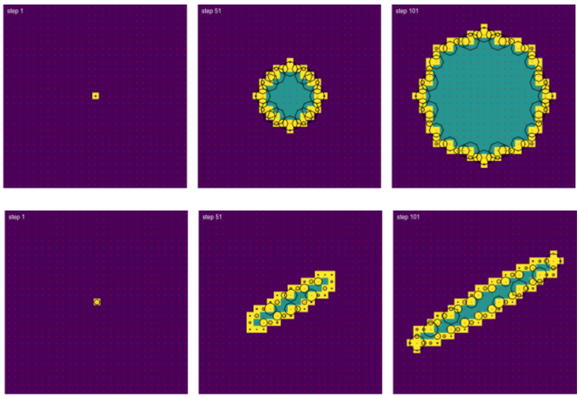
Project description

In the state of art 3D microstructure evolution model framework CASIPT (cellular automata sharp interface phase transformation) the austenite to polygonal ferrite and/or pearlite transformations are in most situations described with acceptable accuracy. However, the transformation of austenite to bainite or to acicular ferrite are not described or not accurately enough. These omissions limit the use of the CASIPT model for product development and limit the accuracy of the online control models. For controlling the temperatures in the hot strip mill run-out-table and in the continuous annealing lines it is also required that a model becomes available that describes the heat of transformation of bainite.

The main scientific goal of this project is to create a physically-based and robust model for 3D description of the bainite and acicular ferrite formation in a polycrystalline material. This model will provide a complete understanding of the effects of morphologies and compositional gradients on the microstructure development.

Research activities

Extending the CASIPT model to include the bainite reaction and formation of acicular/Widmanstätten ferrite was chosen to be the first problem to be tackled in this project. A literature survey has been carried out to get a better understanding on the current views on the bainite reaction and the proposed models for describing the microstructural evolution of bainitic microstructures. In addition, a simplified 2D cellular automata model has been developed using the same fundamental principles from the CASIPT model. This simplified model can be used as a workbench for testing features to be implemented in the CASIPT code.



The images above were obtained with the simplified 2D CA model. In the three first images is represented the isotropic growth of a ferrite particle from austenite. The ferrite grain evolves with an octagonal shape, as expected by the rules of capture of the cellular automaton. In the last three images, the formation of an elongated ferrite particle is simulated by defining a main growth direction is defined along which the capture velocity is set as maximum. The capture velocity then decreases with the distance from the main growth direction following a power law. The result is the development of an elongated ferrite particle, such as expected from the growth of Widmanstätten and bainitic ferrite plates.