Improvement of 3-D mean field models for capillarity driven grain growth based on full field simulations

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Eight initial grain size distributions:
- 7 log-normal and 1 bimodal

Full field simulations as references:
- Immerged volume method using level set functions
- VER composed of 8000 grains
- 25M of tetrahedral elements

Confrontation of full field results with mean field model predictions

Proposition of a new B&T formulation:

\[ \left< R \right>^2 - \left< R_0 \right>^2 = \alpha M \gamma^a \]

Determination of \( \alpha \) and \( n \) by inverse analyses

\[ n = 0.62 \pm 0.14, \quad \ln \alpha = 6.76 \pm 0.34 \]

\( n \) vs. \( \ln(\alpha) \) plot: Chasteel Bi&T Steel formation.

\( R^2 \) error measured on the evolution of \( R \) predicted by full field and B&T model

Heat treatment and initial parameters

Heat treatment:
- \( T = 1050^\circ \mathrm{C}; \quad t = 5h \)
- Isotropic grain boundary energy and mobility
- No second-phase particles

Grains → Modeled grain class

\[ V_i = BM \gamma \left( \frac{1}{R_{cf}} - \frac{1}{R_i} \right) \]

Optimisation of the \( \beta \) value by minimisation of the \( L^2 \) error on the grain size distribution predictions:

Comparison of the grain size distributions with the classical (\( \beta = 1 \)) and new (\( \beta = 1.4 \)) Hillert model

\( L^2 \) error measured on grain size distributions predicted by full field and Hillert model

Improvement of the Hillert model:

\[ V_i = 1.4BM \gamma \left( \frac{1}{R_{cf}} - \frac{1}{R_i} \right) \]