

Mean field modeling of dynamic recrystallization by homogenization of Full field models on 304L

- Objective : Create a dialog between two scales of modeling in order to automatically propose new mean field DRX and PDRX law on the austenitic stainless steel 304L

Metallurgy
μStructure
Rheology

Multi
Scale
Modeling

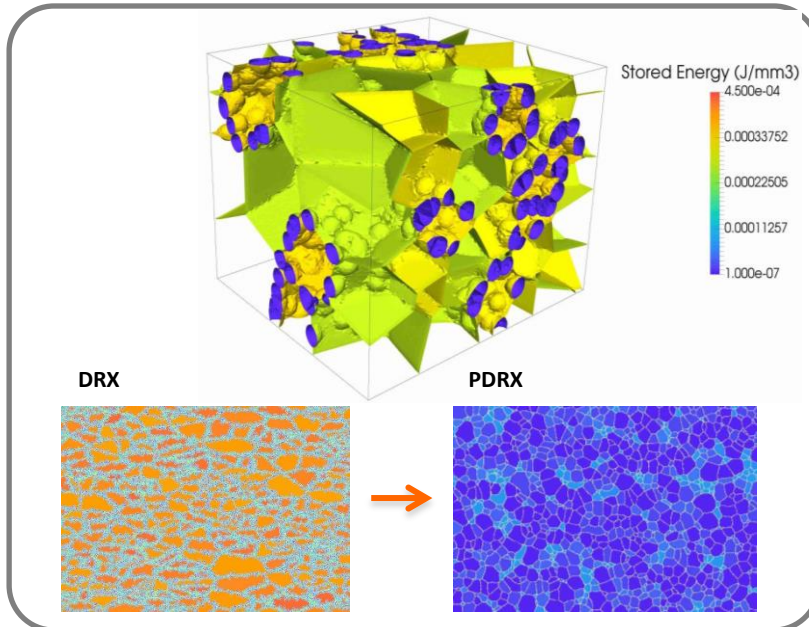
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Work funded by



Full field simulations of DRX and PDRX



Coupling two modeling scales

Mean field simulations of DRX and PDRX

Hardening + recovery

$$\frac{\partial \rho}{\partial \varepsilon} = K_1 - K_2 \rho$$

Nucleation

$$\rho_{cr} = \left(\frac{20\gamma_b \dot{\varepsilon}}{3b l M_b \tau^2} \right)^{(1/3)}$$

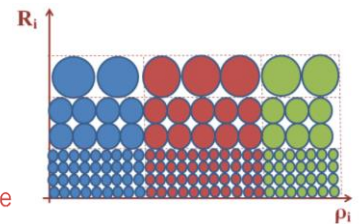
$$\dot{N} = K_g S_c \Delta t$$

Grain boundaries migration

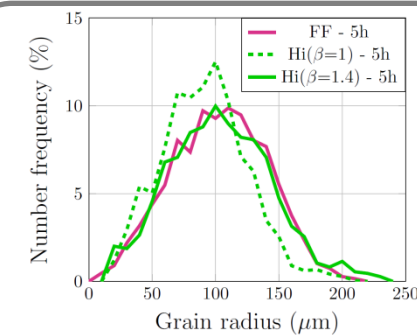
$$v_i = M * \left[\tau(\bar{\rho} - \rho_i) + \gamma \left(\frac{1}{R} - \frac{1}{R_i} \right) \right]$$

Stored energy gradient

Capillary force

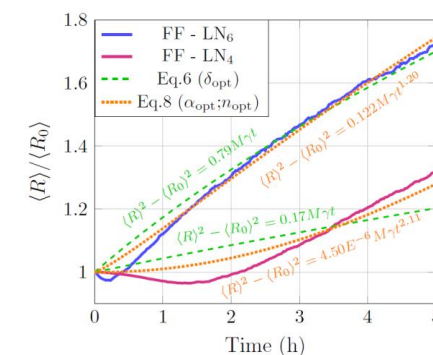


Improvement of mean field models based on full field simulations



Improvement of Hillert model

$$v_i = 1.4M\gamma \left(\frac{1}{R_{cr}} - \frac{1}{R_i} \right)$$



New B&T formulation

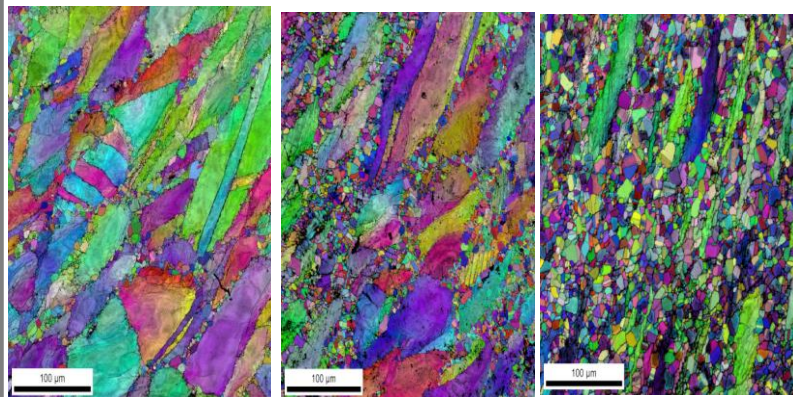
$$\langle R \rangle^2 - \langle R_0 \rangle^2 = \exp^{7.33} \left(\frac{\sigma_0}{\langle R_0 \rangle} \right)^{6.76} M\gamma t^{-0.62 \ln \left(\frac{\sigma_0}{\langle R_0 \rangle} \right) + 0.34}$$

Source : L.Maire et al. JMS 2016

Microstructure analysis

to better understand DRX and PDRX mechanisms and improve models accuracy

Source : PhD M. Zoueri 2015, Inconel 718



Torsion test ($T, \varepsilon, \dot{\varepsilon}$) followed by a quench