DIGIMU®: 2D and 3D Full Field Recrystallization Simulations and Optimization of Multi-Pass Processes

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ABSTRACT

Microstructural predictions on multi-pass processes (e.g. rolling, cogging, becking...) are very challenging due to the strong evolution of the microstructure from the beginning to the end of the process. The difference of grain size and shape between the beginning and the end of the process completely modifies the microstructure topology. The competition between boundary migration, recovery and nucleation leads to complex coupled effects. Moreover, only minor variations of the process parameters (inter strokes wait-times, reheating, and temperature) may have huge effects on the way each mechanism (dynamic recrystallization, post-dynamic recrystallization with few or with numerous nuclei, recovery…) can take place. Classical phenomenological Mean Field (MF) laws or models to predict grain size distribution evolution can then reach their limit. To predict those evolutions and proposed enhanced MF models, the microstructure of the metal must be fully considered, and its evolution must be simulated thanks the *ad hoc* physical laws.

Recent improvements in Full Field finite element microstructural simulations enable to model in reasonable CPU times the discussed phenomena and their coupling: realistic polycrystal generation, grain growth driven by capillarity and stored energy jumps at the boundaries, hardening, recovery, and nucleation. The wide ongoing collaboration between CEMEF MINES ParisTech, 8 renowned French industries and the software editor TRANSVALOR in the French National Agency's Industrial Chair DIGIMU leaded to the industrialization of the robust and easy to handle commercial solution DIGIMU® dedicated to the Recrystallization modeling in context of industrial process conditions.

The simulation of stainless steel rolling and cogging processes with more than 10 passes will be illustrated, underlining the influence of process parameters on the results. A micro-macro approach coupling FE packages DIGIMU® and FORGE®, and the corresponding microstructural models will be presented and discussed.