# Microstructure Control Of Hot Rolling Processing Of Steels Through Thermo-Mechanical FEM

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## Abstract

Hot rolling of steels plays a major role in redefining the final mechanical properties of steels. Such thermo-mechanical processing involves an interplay of a sizable number of variables. During a multi-pass hot rolling schedule, the behaviour of the material depends mainly on temperature, strain rate, and chemistry. The material response is also known to be affected by microstructural factors including grain size and recrystallization. To model the microstructural evolution of a grade of steel during a hot rolling schedule, considering the strain and temperature fields throughout the rolled plate, the Finite Element Method (FEM) approach is coupled with recrystallization constitutive modelling based on physical metallurgy, to predict and control the microstructure of the steel produced via hot working. Initially, the COMSOL Multiphysics is used to simulate 1 pass stand of hot rolling to get the strain and stress fields through the modelled steel plate. For the first configuration, the plasticity model is fed with flow stress (strain) data which depend on steel composition, temperature and strain rate. As for the second configuration, heat transfer model will be coupled to the non-linear plasticity model. For the recrystallization modelling, constitutive equations for dynamic recrystallization were implemented to plot the recrystallized fraction at the end of the pass. Separately, a graphical user interface was developed to model the static recrystallization of the austenite and the evolution of its grain size. A sequence of hot rolling will be then simulated and assessed with respect to in-situ industrial data from the production history of a hot rolling plant.

## Figures used in the abstract

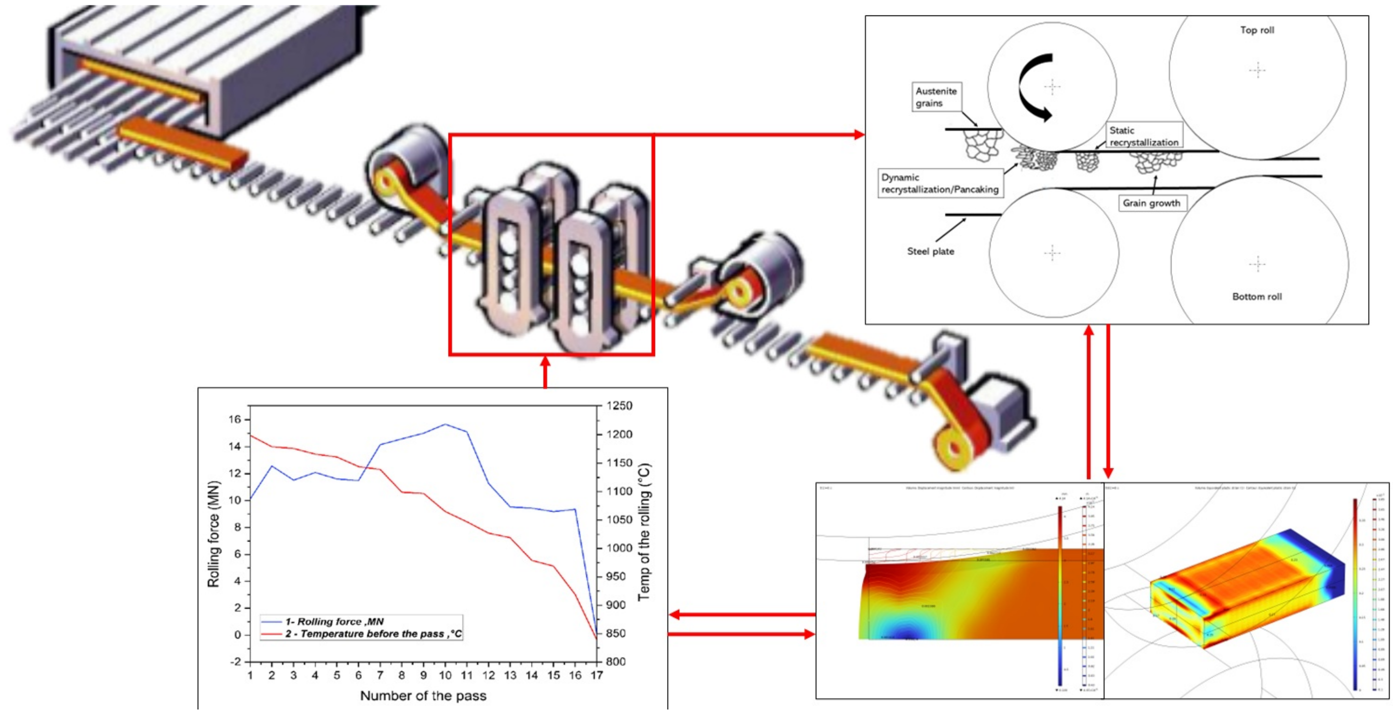


**Figure 1** : The roadmap of the overall methodology bridging thermo-mechanical processing of steel with recrystallization kinetics

| %C | %Si | %Mn | %P | %S |
|---|---|---|---|---|
| 0.087 | 0.003 | 0.34 | 0.025 | 0.02 |

**T(Temperature)= 900°C**

**T= 1000°C**

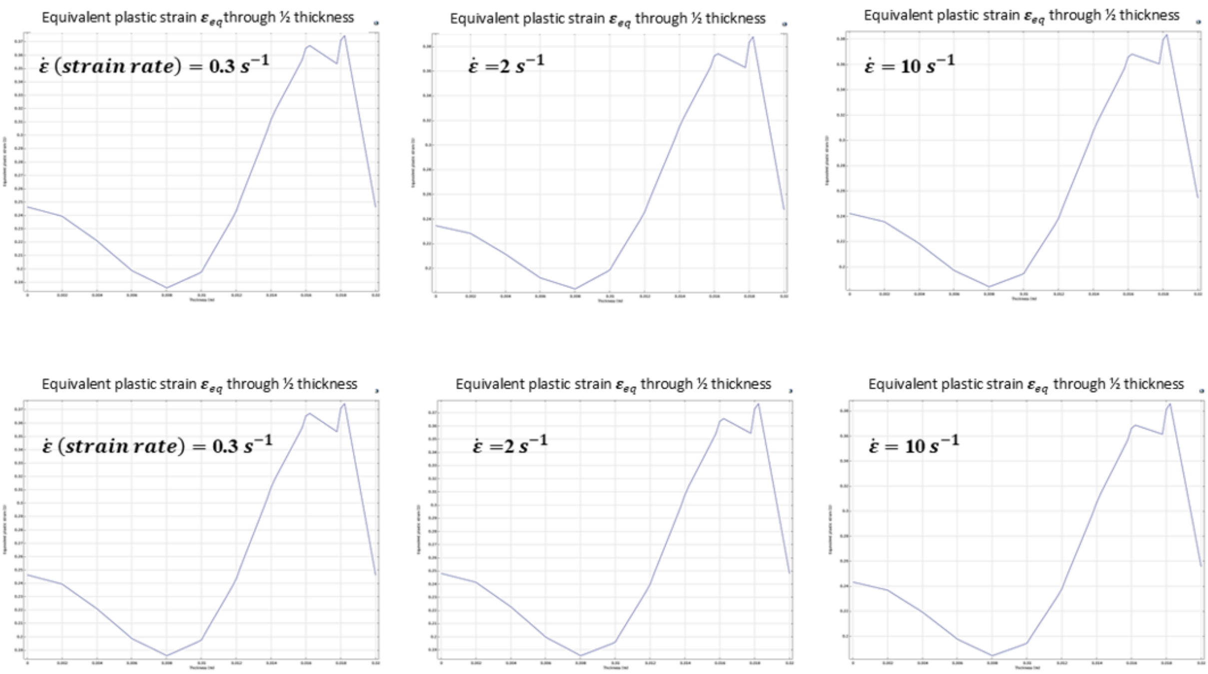


**Figure 2** : The evolution of the equivalent plastic strain through the half thickness of the plate under 1000°C and 900°C respectively for different strain rates

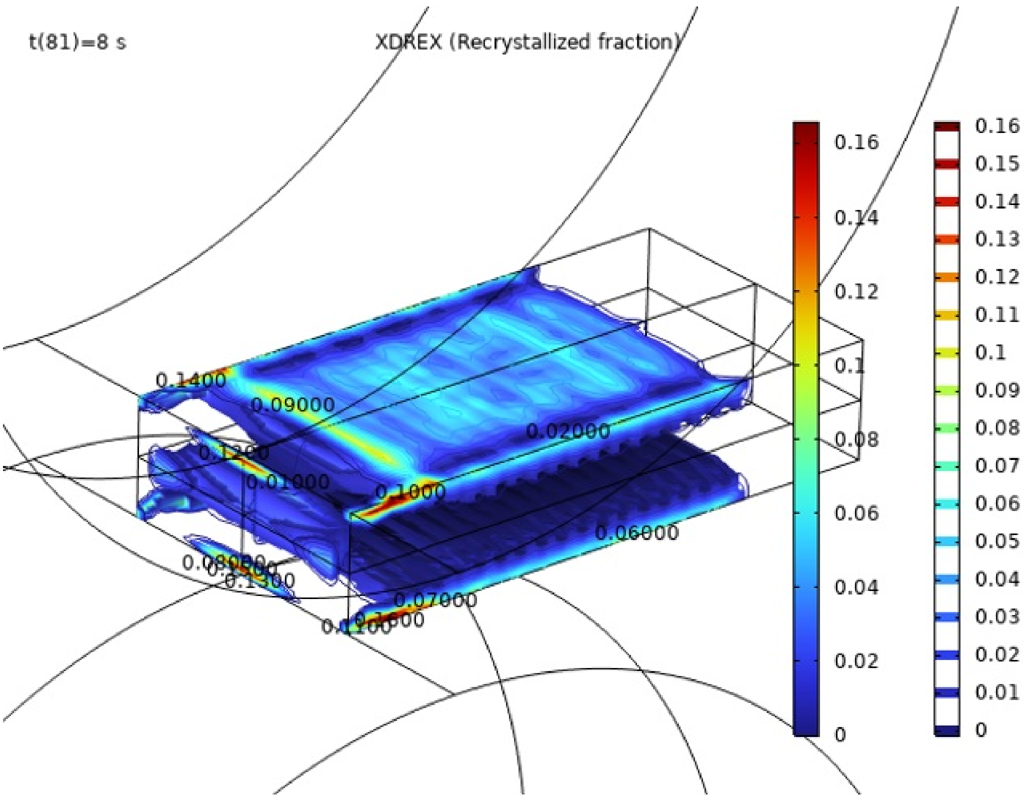


**Figure 3** : Dynamically recrystallized fraction for the steel 0.087wt.%C-0.003wt.%Si-0.34wt.%Mn-0.025wt.%P-0.02wt.%S processed under 1200°C and a strain rate of 0.3 s-1with an initial (austenite) grain size of 70µm.

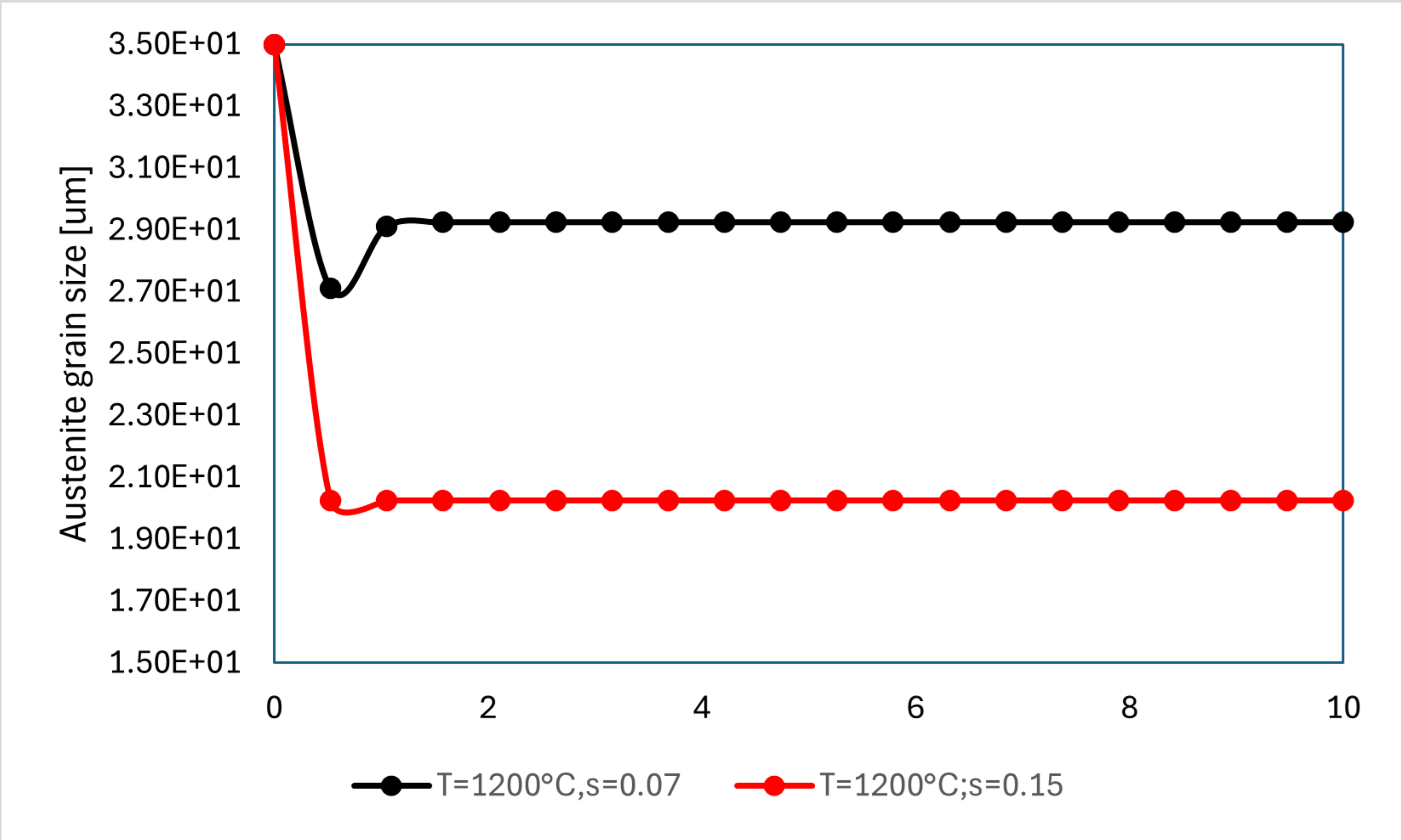


**Figure 4** : Calculated austenite grain size evolution due to static recrystallization based on the retained strain after deformation and dynamic recrystallization under 1200°C and 0.3s-1