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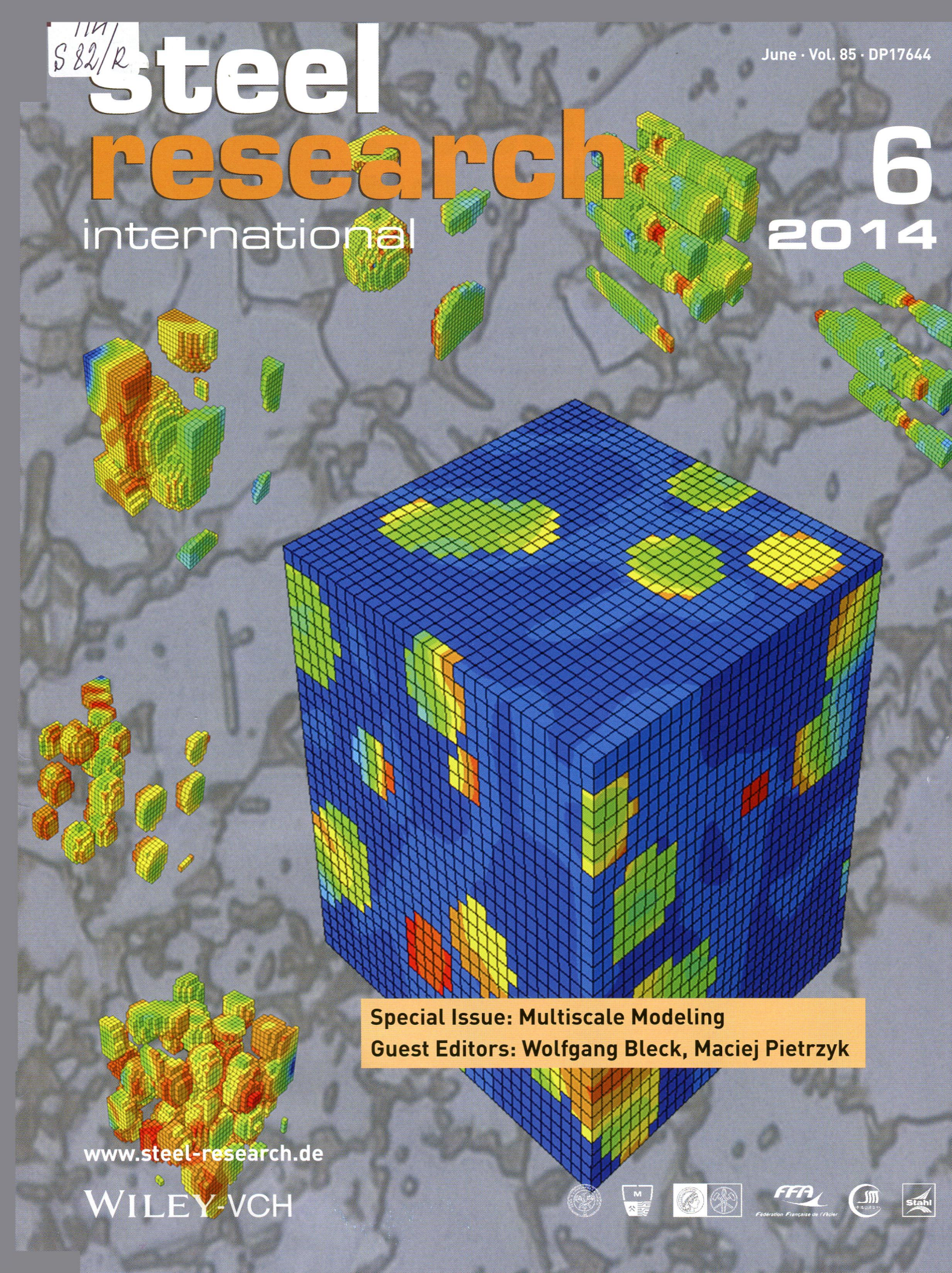

Special Issue: Multiscale Modeling
Guest Editors: Wolfgang Bleck, Maciej Pietrzyk

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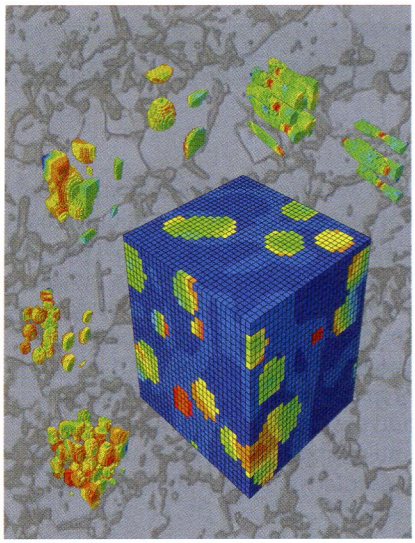

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Cover Photo:

The cover front figure shows the representative volume elements (RVEs) of a dual-phase steel constructed based on its real microstructure image on background. Different RVEs could be constructed according to the shapes and volume fractions of the martensitic inclusions. The RVEs can be applied to the FE simulations for predicting the mechanical behaviors under various strain path changes.

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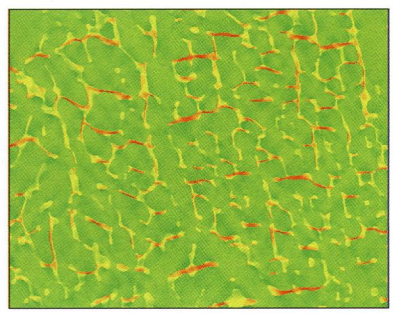

Microstructure-based finite element modeling has been performed on different microstructures of an austenitic-ferritic stainless steel using the constitutive behavior of individual phase obtained from micropillar compression tests. The simulated plastic strain and stress distribution reveal the effect of area fraction, morphology as well as the distribution of ferrite phase on the mechanical properties of the material.

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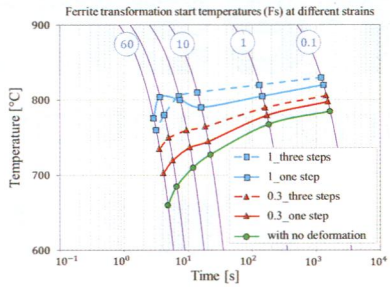
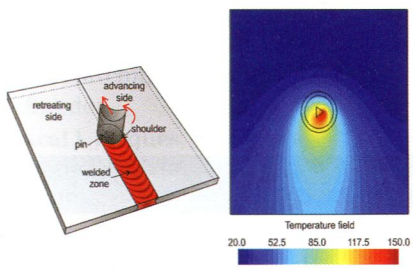
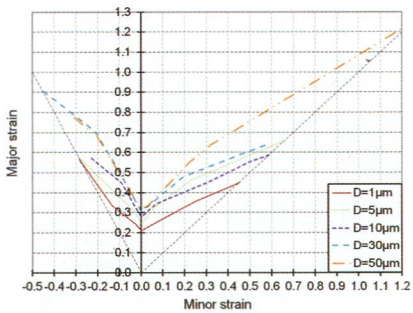


This work presents different modeling approaches for the description of the microstructure evolution in a typical C–Mn micro-alloyed steel for pipes and tubes in the oil field industry. A comparison between the continuous-cooling-transformation (CCT) diagram of the material with no deformation and the DCCT diagram after single- and multiple-step deformation is presented and with experiments validated.



The aim of the paper is to present and compare a fluid and a solid approach applied to the numerical simulation of the friction stir welding process with non-cylindrical pins. Both approaches use the Arbitrary Lagrangian–Eulerian formalism in order to avoid mesh distorsions that would inevitably appear while using a more classical approach such as the updated Lagrangian formalism.



In this study, an elastic–plastic self-consistent (EPSC) polycrystalline model is coupled with a bifurcation-based localization criterion to investigate relationships between microstructural and morphological properties and formability of single-phase BCC steels. The interest in such a combined theoretical-numerical prediction tool is to classify materials in terms of ductility and to optimize material properties or to design new grades of steel with enhanced in-use mechanical properties.

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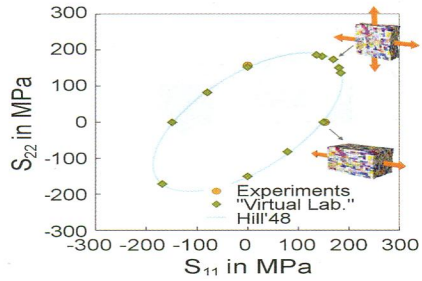
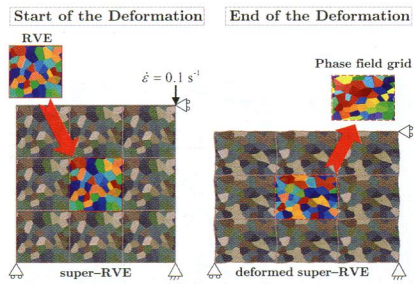
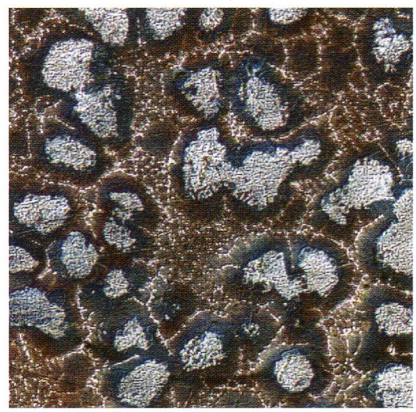


In this work a virtual testing concept is applied to extend the experimental data set for metal forming simulations. The behavior of polycrystalline microstructures is modeled by using finite element solutions in combination with crystal plasticity. The success of the strategy is validated for the mild steel DC04 where key material values are predicted successfully.



In this work, crystal plasticity finite element method is applied to the static recrystallization of a high manganese steel (X60Mn23). The hardening behavior is captured by CPFEM and its output is used to generate an input for the phase field study of static recrystallization using a developed dedicated mapping scheme. The proposed method is able to predict the main features of the static recrystallization kinetics.



The model of solute's diffusion is introduced for the simulation of the diffusion-controlled equiaxed solidification. Averaged Voronoi Polyhedron is adopted as the shape of the analyzed domain. As opposed to known solutions based on the spherical domains, proposed one takes into account smaller volume fraction of the peripheral regions of the grain due to grains impingements and predicts true volume fraction and composition of the vanishing intercrystalline liquid.

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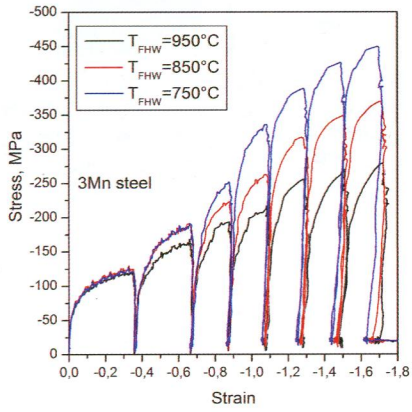
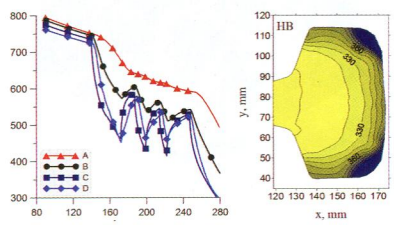
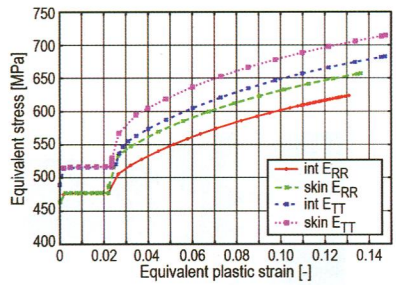


The study clarifies the effects of Mn addition and Nb microaddition as well as finishing hot-working temperature on the hot deformation resistance and microstructure of four medium-Mn–Al-containing thermomechanically processed steels. Physical simulation of thermomechanical hot strip rolling was carried out under various conditions of finishing hotworking temperature varying in a range between 950 and 750 °C. The finishing deformation temperature has a crucial effect on flow stresses and retained austenite content.



The paper is about the design of the thermal cycle for perlitic rails heat treatment with respect to the maximum of the wear resistance. The FE simulation of controlled cooling of rails coupled with microstructure evolution model, related to the rolling surface hardness, has been used. Sensitivity analysis has been applied to select the parameters with the largest influence on the process. The best thermal cycle has been determined.



A multi-scale approach, involving a two-level homogenization and a localization analysis after macro-simulation, is used to predict the impact of different ferrite-pearlite microstructures on the U-O forming process of a pipeline steel. Effective plastic flow curves of the X65 steel are derived for a central and surficial microstructure (see figure). Their anisotropy is noticeable and the effect of reduced lamella spacing of pearlite at the skin is quantified.

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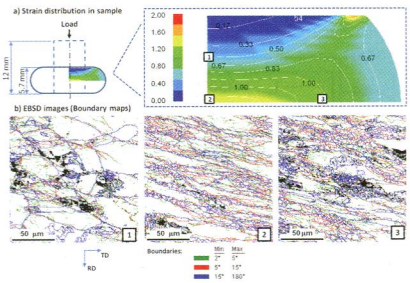
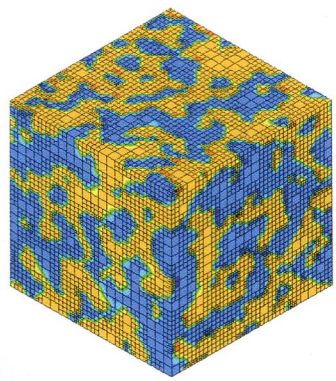
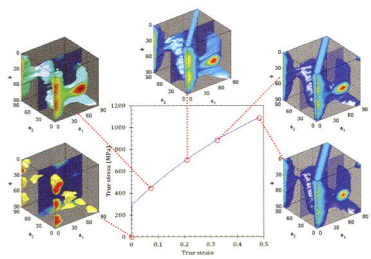


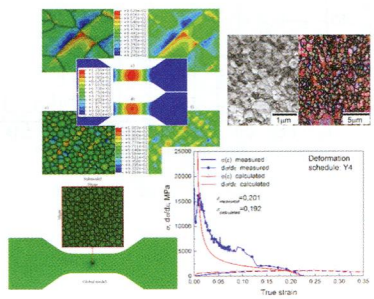
Inverse analysis, which couples a thermomechanical FE analysis with data from single- and double-compression tests, is used to obtain the microstructure kinetics of type 316 stainless steel. In the FE analysis, a proposed flow curve is substituted independently on every element, which compensates the effect of inhomogeneous distributions of deformation and temperature in the samples.



The paper presents a significant performance improvement to the workflow used in modeling boundary-value problems in complex materials. We discuss a procedure for solving boundary-value problems and finding a representation of a given microstructure in a desired functional base. Developed approach is validated during investigation of a linear elastic deformation of a dual phase ferritic–martensitic steel under thermal loading conditions.



Typical of fcc materials, texture measurements during the uniaxial tensile loading of a fully recrystallized TWIP steel returns a relatively stronger <100> and a weaker <111> double fiber texture. The VPSC model successfully tracked the texture evolution by detailing the contribution of slip and twinning when latent hardening effects are included or excluded.



This paper discusses the interrelationships between processing parameters, microstructure, and mechanical behavior of microalloyed ultrafine-grained steels. Grain refinement possibilities of microalloyed steels using Advanced Thermomechanical Processing and Severe Plastic Deformation routes were studied. Based on that, in the second part of the work, the recent work on multiscale modeling has been revised in the light of its potential application to simulation of chosen SPD processes.