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Editorial

Crystal Plasticity

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The Special Issue on "Crystal Plasticity" is a collection of 25 original articles (including one review paper) dedicated to theoretical and experimental research works providing new insights and practical findings in the field of crystal plasticity-related topics.

Crystal plasticity is an inherently multi-scale process starting at the atomic scale (dislocation cores) towards substructural dislocation arrangements in a single grain and up to the macroscopic mechanical response of the material. Its multi-dimensional nature and a high practical importance build a space for scientists and engineers working within various methodological domains.

The main intention of this Special Issue was to present a wide spectrum of the Crystals Plasticity area, i.e., to combine a mathematical modeling with experimental investigations on the processing/structure/property relationship, to show its practical importance in examining both "traditional" and novel materials (e.g., steels and high-entropy alloys) and processing techniques (e.g., hot-rolling and additive manufacturing). After collecting all the papers, I am extremely happy that a great contribution of researchers all over the world (from 18 different countries!) allowed the attainment of this goal. All the papers can be virtually divided into three groups, namely (i) "modelling and simulation"; (ii) "methodological aspects" and (iii) "experiments on process/structure/properties relationship".

In terms of more theoretical works in which crystal plasticity model attempts were evaluated to reproduce the complex deformation processes of polycrystalline metals, Zubelewicz [1] has provided an extensive review on mechanisms-based transitional viscoplasticity and Nguyen et al. [2] have made a short review of computational modeling of dislocation slip mechanisms. Masood Chaudry et al. [3] have compared the results of Electron Backscatter Diffraction measurements and viscoplastic self-consistent calculations upon analysis of Ca-induced plasticity in Mg alloys, while a similar approach was also applied by Galán-López and Hidalgo [4] to stainless steel. Other examples of such works are modeling the local deformation and transformation behavior of cast metal matrix composite by using a continuum mechanics-based crystal plasticity model (Qayyum et al. [5]) or mathematical modeling of plastic deformation of a tube from dispersion-hardened aluminum alloy in an inhomogeneous temperature field (Matvienko et al [6]). Ou et al. [7] have incorporated a crystal plasticity finite element model for predicting a crack initiation in additively manufactured IN718 alloy, while Kosuge et al. [8] have utilized strain gradient plasticity theory based on the finite element method to estimate a behavior of steel structures subjected to large complicated pre-strains. Further examples on crystal plasticity modeling involve a reaction stress model (Zhang et al. [9]), statistical crystal plasticity constitutive models of polycrystalline metals and alloys (Shveykin et al. [10]) or 3D representative volume element approach (Qayyum et al. [11]). Furthermore, a theoretical work related to yield surfaces and slip systems has been provided by Holmedal [12].

The second group of papers is dedicated towards the development of new metodological aspects related to examining crystal plasticity issues (also at the microscale). In this field, Yanagida et al. [13] have investigated the characteristic deformation behavior of a precipitation strengthening-type Cu-Ni-Si alloy by microcompression of Focused Ion Beam produced specimens, while Fang et al. [14] have made an attempt to bridge the gap between bulk compression and indentation tests on room-temperature plasticity in oxides.

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Minárik and Martinkovič [15] have designed a computationally low consuming procedure for quantification of local deformation in a grained structure based on the distortion of the image of this structure in a cross-sectional view.

Finally, the last group of papers deals with an experimental assessment of structural and mechanical properties evolution upon plastic deformation of various metallic materials. The following subjects are described:

- an influence of trapped gas on pore healing under hot isostatic pressing in nickel-base superalloys (Prasad et al. [16];
- a microstructural influence on stretch flangeability of ferrite–martensite dual-phase steels (Kim et al. [17]);
- an effect of equal-channel angular pressing on microstructure, mechanical properties, and biodegradation behavior of Mg alloyed with Ag and Gd (Straumal et al. [18]);
- kinetics of capability aging in Ti-13Nb-13Zr alloy (Lee et al. [19]);
- mechanisms of grain structure evolution in a quenched medium carbon steel during warm deformation (Panov et al. [20]);
- a microstructure, texture, and strength development during high-pressure torsion of CrMnFeCoNi high-entropy alloy (Skrotzki et al. [21]);
- an effect of strain on transformation diagrams of 100Cr6 steel (Kawulok et al. [22]);
- mechanical and thermal properties of low-density Al20+xCr20-xMo20-yTi20V20+y alloys (Bhandari et al. [23]);
- the late age dynamic strength of high-volume fly ash concrete with nano-silica and polypropylene fibres (Mussa et al. [24]);
- dislocation reactions governing low-temperature and high-stress creep of ni-base single crystal superalloys (Burger et al [25]).

I hope that this collection of papers will meet expectations of readers looking for new advances in the Crystal Plasticity field, as well as it bringing inspirations for further research work.

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