Foreword

Multi-Scale Modeling of Microstructure Deformation in Material Processing

Modern market demands for innovative 21st century materials and products are a driving force for advanced research on innovative engineering materials with elevated properties *e.g.*, advanced high strength steels, aluminum, magnesium, titanium, copper alloys, metallic foams, graphene, *etc.* Unfortunately, these properties are obtained by the creation of sophisticated multiphase microstructures what makes the production process very difficult. Interaction at the nano and micro scale level between features of the microstructure and the surrounding material under processing or exploitation conditions directly results in excellent properties at the macro scale level.

To deal with that issue and provide a support to extensive experimental research, innovative numerical approaches often based on the multi scale idea were proposed and have been intensively developed for the last decade. Advantages provided by a combination of a variety of numerical approaches: finite element (FEM), crystal plasticity finite element (CPFEM), extended finite element (XFEM), finite volume (FVM), boundary element (BEM), mesh free, multi grid methods, Monte Carlo (MC), Cellular Automata (CA), Molecular Dynamics (MD), Molecular Statics (MS), Level set methods, Fast Fourier Transformation, Digital Material Representation (DMR), *etc.* are being successfully used in many practical industrial applications.

A mini-symposium on ''multi-scale modeling of microstructure deformation in material processing'', cyclically organized during Material Science and Technology MS&T conferences, has become a forum for wide discussions and dissemination of results among scientific multi-scale community from around the world. Recent developments in the aforementioned numerical techniques are presented each year during the course of that mini-symposium.

To highlight immense capabilities of multi scale methodology, for the second time, we have decided to present to the broader audience, *via* the Metallurgical and Material Transactions journal, selected papers from that symposium. The first special issue printed in 2013 had a good reception among the scientific community. Thus, this time we have also selected several papers presenting applications of modern numerical solutions to modelling complex multiphase materials. Pietrzyk *et al.* is investigating multi scale numerical modelling techniques with different levels of complexity to predict multiphase steel microstructure evolution during thermo-mechanical treatment. The work by Perzynski *et al.* is dealing with explicit failure modelling in multiphase steels under processing conditions. Finally, the work by Sharifi and Larouche presents numerical modelling on the basis of explicit microstructure representation of the multiphase aluminium copper alloys.

Various possible applications of these numerical models can be appreciated after reading the presented papers.

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