In-situ characterization of grain-level mechanics in metastable austenitic stainless steel using high-energy X-ray diffraction microscopy

Matthias Bönisch[a], Jonathan Wright[b], Wolfgang Ludwig[b,c], Etienne Brodu[a], Pushkar Prakash Dhekne[a], Wolfgang Pantleon[d], Marc Seefeldt[a]

[a] *KU Leuven, Department of Materials Engineering, 3001 Leuven, Belgium*

[b] *European Synchrotron Radiation Facility, 38000 Grenoble, France*

[c] *INSA Lyon, MATEIS, 69621 Villeurbanne, France*

[d] *Technical University of Denmark, Department of Mechanical Engineering, 2800 Kgs. Lyngby, Denmark*

[a]*matthias.bonisch@kuleuven.be*

Metastable austenitic stainless steels (MASS) - a class of transformation-induced plasticity (TRIP) alloys with widespread use in transportation and chemical industries - deform by a combination of martensitic transformation and slip, enabling superior strain-hardening and ductility. During straining, a dynamically changing microstructure of grains composed of austenite and martensite forms, governing the macroscopic mechanical performance. Understanding the underlying mechanics on the level of individual grains is crucial for the success of a wide range of technological applications improving our daily lives.

Aiming to reveal the interdependence of TRIP and the 3D microstructure in a phase-, grain-, and time-resolved manner, we performed combined diffraction contrast tomography (DCT) and in-situ scanning 3D X-ray diffraction (3DXRD) experiments on an EN 1.4318 MASS with an austenite grain size of ~100 µm. By employing a 2.5 µm pencil beam for scanning 3DXRD we seek to elucidate the evolution of the local intragranular mechanics of deeply-embedded, individual austenite grains relative to the mechanical behavior of the polycrystal during tensile loading. Latest outcomes will be presented and challenges in data analysis due to the simultaneous activity of phase transformation and slip will be discussed.

Keywords: In-situ 3DXRD, Micromechanics, Stainless steel, TRIP, Martensite.

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