ICSMA19 Metz, France, June 26 - July 1, 2022
International Conference on Strength of Materials

Micromechanics of oxide inclusions in ferrous alloys: interfacial strength

David Hernández Escobar[a], Alejandra Slagter[a], Joris Everaerts[a,b], Léa Deillon[a,c] and Andreas Mortensen[a]

[a] *Laboratory for Mechanical Metallurgy, Institute of Materials, École Polytechnique Fédérale de Lausanne (EPFL), Station 12, Lausanne CH-1015, Switzerland*

[b] *Present affiliation: Department of Materials Engineering, KU Leuven, Kasteelpark Arenberg 44 box 2450, 3001 Leuven, Belgium*

[c] *Present affiliation: Department of Mechanical and Process Engineering, ETH Zürich, Technoparkstr. 1, 8005 Zürich, Switzerland*

[a]*david.hernandezescobar@epfl.ch*

The presence of non-metallic inclusions (NMI), which form during processing or subsequent thermal treatments, plays a critical role in the final mechanical behaviour of steels and ferrous alloys. Research progress over the years has enabled an improved control over the type, size, composition, and distribution of NMI; however, despite the significant work towards tailoring the NMI characteristics, their intrinsic mechanical properties as well as their influence on the ferrous matrix are yet to be fully explored and understood. In the present work, the interfacial shear strength (IFSS) of silica (SiO_2) inclusions within a Fe matrix is investigated by following a novel approach, by which spherical SiO_2 inclusions are first exposed by electrochemical dissolution of the Fe matrix, and then carved into a “L-shape” by means of focused ion beam (FIB) milling. Using a micromechanical testing device equipped with a flat punch, the L-shaped SiO_2 inclusions are then individually tested in compression until detachment from the matrix where they were originally embedded is recorded. The horizontal and lateral forces measured during testing, together with additional inclusion-matrix geometrical parameters, are then interpreted using a theoretically derived formula to estimate the IFSS between the SiO_2 inclusions and the Fe matrix.

Keywords: inclusions, iron, steel, silica, interfacial strength

Acknowledgment: This work is sponsored by the Swiss National Science Foundation, Grant No. 200021_182557