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Modelling of the tensile behavior of low-carbon martensitic steels based on experimentally determined microstructural distributions

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The tensile properties of martensitic steels can be properly explained and modeled if the martensite is considered as a composite material [1–3], as a result of the dispersion of local mechanical behavior, resulting from different contributions. The present work presents a model based on microstructural distributions for as-quenched martensite, including dislocation density and lath size as well as internal stresses.

The distribution of local dislocation density was determined by in-situ High-Energy X-Ray Diffraction (HEXRD) experiments [4] as well as the domain size distribution (determined by EBSD), for three low-carbon steels (from 0.11 to 0.31 wt.% C). The mentioned contributions were translated into distributions of microstructural strengthening and added to the solid solution hardening (Figure 1a). Internal stress distribution was additionally considered to the microstructural ones and then combined to estimate yield strength distribution. The results of the three four? contribution-based model were compared with experimental ones, founding good agreement between the results, Figure 1b.

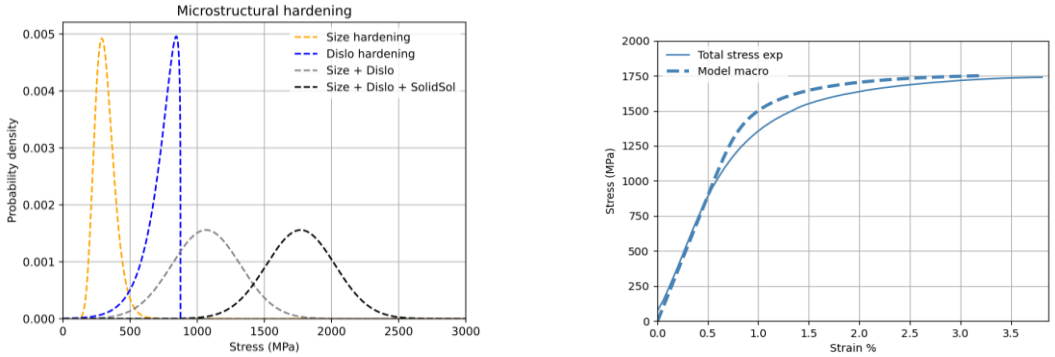

Figure 1: a) Yield strength distributions of all considered microstructural contributions for the modelled tensile behavior presented in b) with the experimental curve.

References

[1] S. Allain, O. Bouaziz, M. Takahashi, ISIJ Int. 52 (2012) 717–722.
[2] B. Hutchinson, D. Lindell, M. Barnett, ISIJ Int. 55 (2015) 1114–1122.
[3] L.Y. Wang, Y.X. Wu, W.W. Sun, Y. Bréchet, L. Brassart, A. Arlazarov, C.R. Hutchinson, Acta Mater. (2020).
[4] J. Macchi, S. Gaudez, G. Geandier, J. Teixeira, S. Denis, F. Bonnet, S.Y.P. Allain, Mater. Sci. Eng. A 800 (2021) 140249.