
Full magnetoelastic behavior of Dual-phase steel in biaxial mechanical loading condition

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Abstract

Advanced High Strength Steels (AHSS) raise a growing interest as weight saving solutions with high mechanical properties due to a complex (low scale and multiphased) microstructure. Online non-destructive magnetic monitoring is used to control the quality of these steels. This control is done on laminated steel sheets which undergo variable multiaxial mechanical loads. And due to magneto-mechanical coupling, miss-indication of the quality and false-positives can occur. This explains why stress influence on magnetic properties has to be taken into account, especially considering multiaxial mechanical loading. An adequate online control supposes then to develop predictive magneto-mechanical models and to use them to correct online measurements. This global approach requires to carry out experiments involving magnetic measurements under multiaxial stress for an accurate validation and/or identification of model parameters.

In this study a new set-up is presented (1) allowing for the measurement of anhysteretic and cyclic magnetic and magnetostriction behaviors under biaxial stress. Results show a clear asymmetry of the magnetic behavior in uniaxial tension and compression. A bitension hardly changes the susceptibility while a bicompression divides it by two. A shear situation with negative stress along the magnetic measurement direction leads to the lowest susceptibility values. A magneto-mechanical model is next proposed, using a multiscale approach (2) and considering a mix of soft (ferrite) and hard (martensite) phases. This model is based on the description of the magnetic domains distribution depending on their Gibbs free energy density. Localization and homogenization steps require to use a self-consistent scheme following Eshelby's inclusion model at the grain scale. Experiments and modeling are finally compared highlighting some similar trends.

(1) J. Le Soudeer, O. Hubert, Full magnetoelastic behavior of dual-phase steel in biaxial mechanical loading condition - equivalent stress for magnetostriction, *Journal of Magnetism and Magnetic Materials* (under review).

(2) L. Daniel, O. Hubert, N. Buiroon, R. Billardon, Reversible magneto-elastic behavior: A multiscale approach, *Journal of the Mechanics and Physics of Solids* 56 (3) (2008) 1018–1042. doi:10.1016/j.jmps.2007.06.003.

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