INTERNAL FRICTION STUDY OF HYDROGEN INTERACTIONS IN DUPLEX STAINLESS STEEL

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Duplex stainless steels are interesting materials due to their good corrosion resistance as well as their excellent mechanical properties. This combination of strength, toughness and ductility originates from their dual phase matrix, consisting of approximately equal amounts of austenite (FCC) and ferrite (BCC). The use of these steels for hydrogen applications requires thorough understanding of the hydrogen embrittlement behavior, in particular the hydrogen interactions with defects, i.e. dislocations and vacancies.

Often thermal desorption spectroscopy is used to evaluate the hydrogen interaction with different microstructural defects. However, this method is less suitable for duplex steels due to the dominant effect of hydrogen diffusion through the austenite phase, obscuring all other interactions[1]. Therefore, other advanced characterization techniques are needed to study the hydrogen interactions in this dual phase matrix. In this regard, the internal friction (IF) technique could be used as it provides information on both the motion of microstructural defects, such as dislocations, as well as on the distribution of small interstitials, i.e. carbon, nitrogen, and hydrogen, and their interactions with dislocations. Indeed, it has been demonstrated that detailed analysis of the IF spectra allows to gain insight in the interaction of hydrogen with different dislocation types and vacancy clusters in BCC steels[2,3]. Moreover, interstitial atoms dissolved in the austenite lattice are also known to result in specific IF peaks[4] as it is schematically illustrated for the BCC and FCC lattices in Fig. 1. Clearly, IF analysis may be a powerful tool in the investigation of the hydrogen behavior in duplex materials.

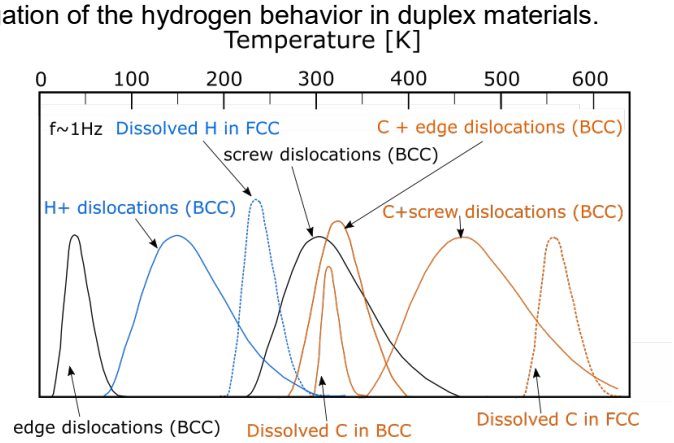

Fig. 1- Schematic illustration of IF peaks in BCC and FCC steel

This study evaluates the potential of the IF technique in the characterization of the hydrogen distribution and defect interactions in the duplex steel microstructure. For this purpose, a 2205 duplex stainless steel was subjected to various conditions of hydrogen charging and plastic deformation. The hydrogen content introduced by electrochemical charging was measured via hot extraction at 1220 K. Varying the charging time from 20h to 168h resulted in a hydrogen content of 88.1 ± 16.5 wppm to 439.5 ± 66.5 wppm. The IF spectra of as-provided and H-charged samples were measured in the temperature range between 100 and 800 K, in both heating and cooling regimes. Careful analysis of the observed relaxation processes was performed based on the Debye equations, using as input the literature data from first principle calculations. Accompanied EBSD and XRD analysis were used to characterize the as received matrix as well as the deformation introduced via plastic straining. Consequently, the combination of advanced characterization techniques allowed gaining new insights in the influence of deformation on the hydrogen distribution in FCC/BCC lattices.

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