HYDROGEN ENHANCED CRACKING STUDIES BY IN-SITU ELECTROCHEMICAL MICRO CANTILEVER BENDING TEST

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Hydrogen (H)-Induced degradation of metals has been a severe problem in different industrial fields. Since H has a strong tendency to segregate in structure defects, grain boundary (GB) importance becomes even more dominated in the H-embrittlement studies. GBs are considered as one of the potential sites for initiation of this catastrophic phenomenon in the polycrystalline materials. To investigate the mechanism causing H-embrittlement, a method is required to resolve the H interaction with the micro-structure and crystal defects such as GBs in the same length scale. In this study, we introduce an in-situ electrochemical micro-cantilever bending (ECCB) test of bi-crystal beams with a selected type of GBs. ECCB tests were performed using a nano-indenter with an integrated miniaturized electrochemical cell. Fe- 3wt%Si and Ni samples were used in this study. Charging the micro sized cantilevers under cathodic potential during the in situ ECCB testing, assured uniform concentration of hydrogen in the GB during bending tests. The results were compared with the bi-crystal cantilevers bent in the air. Secondary electron imaging and electron backscatter diffraction were used to analyze the deformation substructures after the test. The load-displacement curves reveal continuous decrease in the flow stress for the cantilevers bent in the presence of hydrogen. The flow stress was constant for the beams bent in air. The secondary electron images show a crack propagation in the presence of hydrogen. This method overcomes the problems that arise from out gassing of hydrogen during ex-situ testing. Furthermore, examination of hydrogen interaction with a specific type of GB is in the same microstructural length scale.

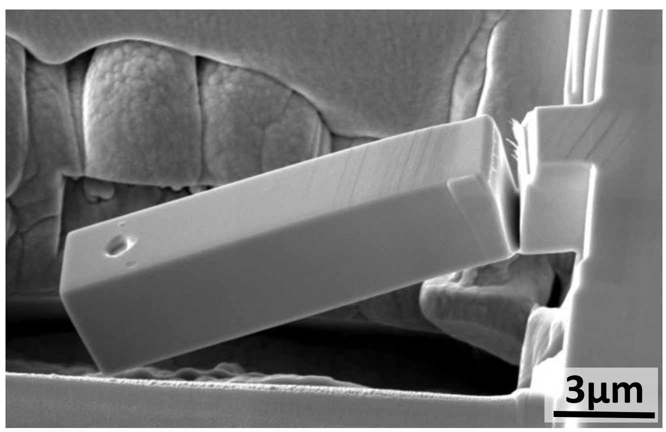

Figure 1 – Bi-crystal cantilever of nickel bent in the presence of hydrogen.