Effects of Hydrogen on Fatigue Properties of Metals Used for Fuel Cell Systems

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ABSTRACT

To solve the global warming problem, development and commercialization of fuel cell systems are being promoted. Fuel cell systems are based on use of hydrogen energy and the future society supported by hydrogen energy is called “the hydrogen society”. For the achievement of the hydrogen society, various technical problems must be solved in the near future. Among various mechanical engineering and material science problems, fatigue of materials exposed to hydrogen environment is of particular importance.

In the present paper, fatigue properties of several steels to be used for the fuel cell (FC) system were investigated. In the FC system, various steels, mostly stainless steels, are used in hydrogen environment under cyclic loading. In this study, hydrogen was artificially charged into specimens of four types of stainless steels (austenitic, ferritic and martensitic), a Cr-Mo high strength steel and an annealed 0.47%C steel, and the fatigue properties were compared with the specimens without hydrogen charge. In the case of the martensitic stainless steel and the Cr-Mo alloy, the influence of hydrogen on fatigue strength and fatigue life was remarkable. The influence of hydrogen charge on fatigue crack growth was also remarkable in all types of stainless steels. The observation of slip bands nucleation in the annealed 0.47%C steel revealed that slip bands produced in the hydrogen charged specimens were very discrete, though those in the specimens without hydrogen charge were spread over ferrites with number of cycles.