Project Subjects

Stress Corrosion Cracking in Light Water Reactors

Background and Objective

Stress corrosion cracking (SCC) is one of the major degradation events to be considered in long-term reactor operation. Countermeasures against SCC are residual stress improvement, water chemistry improvement, application of alternative material and so on. In addition, Fitness-for-Service code of the Japan Society of Mechanical Engineers has been applied on some plants. The code describes methods of inspection, evaluation and repair/replacement. Operation with remaining flaws is permitted if the detected flaw is evaluated as non-hazardous during the evaluation period. The evaluation method will be more accurate if state of the art knowledge on SCC is reflected on the code.

The object of our research is to obtain SCC related data in order to update the code or develop a countermeasure technique. Current programs focus on investigation of SCC propagation behavior around a weld joint and evaluation of the relationships between microstructures of material and SCC.

Main results

1. SCC propagation behavior around a weld joint of low carbon stainless steel

SCC propagation behavior from base metal to weld metal was observed in detail in a previous study using a weld joint of hot rolled low carbon stainless steel bar. It was observed that crack propagation from the matrix to the weld metal hardly occurs. A new specimen obtained from an actual weld joint of a PLR piping is used for the same experiment this time. Cracks in the new specimen propagate along a weld line accompanying branched sub-cracks and hardly intrudes to a weld metal (Fig.1). This result is same as that of the weld joint of hot rolled bar. Most of the cracks are arrested on a weld line. A few cracks propagate into the weld metal but the crack length in weld metal is usually less than 100 μm (Fig.2).

2. SCC initiation behavior of stainless steel

It is known that SCC initiation properties are influenced by surface hardness of material. The hardness depends on a plastic strain that is changed with machined process. In order to establish a method to control hardness of a specimen surface, the effects of feed rate and shaft rotation rate of the milling machine on the surface hardness were investigated (Fig.3). It is found that the feed rate changes the distribution of plastic strain on the specimen surface. The number of cracks on the specimen in which high plastic strain regions are locally induced is greater than that of the specimen in which high plastic strain are uniformly induced (Fig.4).

Other reports [Q09017]

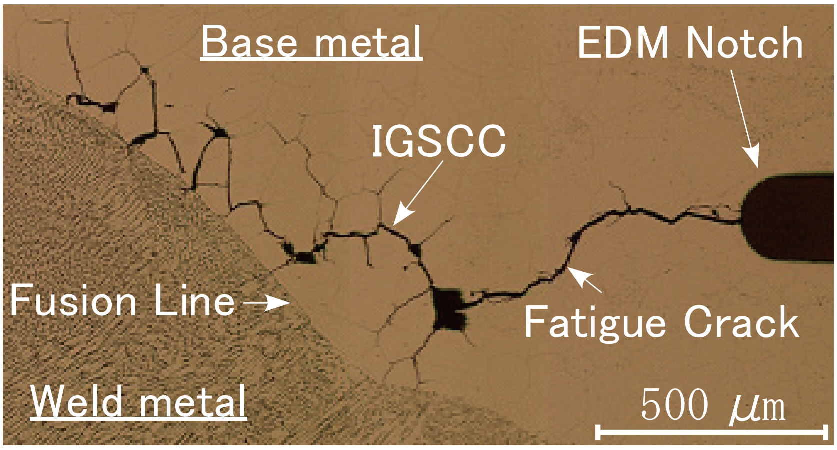

Fig.1 SCC propagation behavior around weld joint

Load is applied on the direction of vertical in this figure, and SCC propagated from the fatigue crack tip to the left side in this figure.

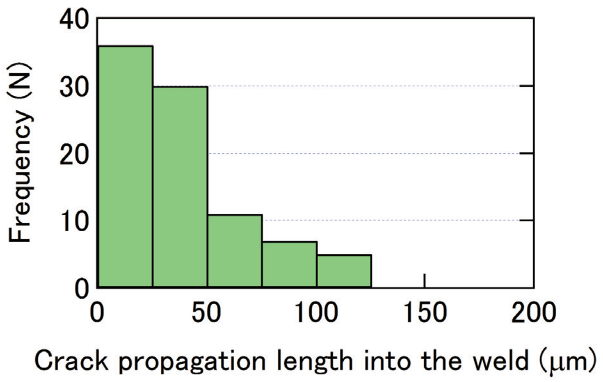

Fig.2 Crack length distribution in weld metal

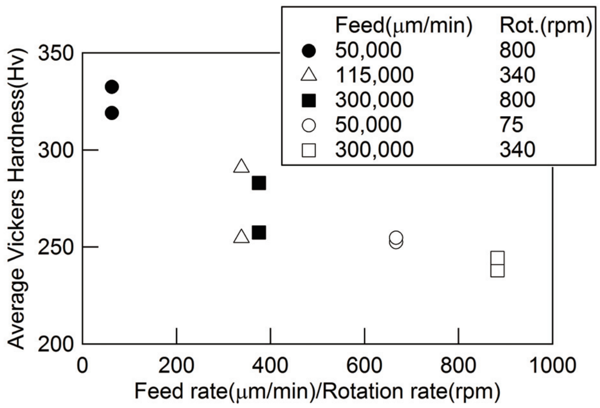

Fig. 3 Relationships between settings of milling machine and surface hardness of the specimen

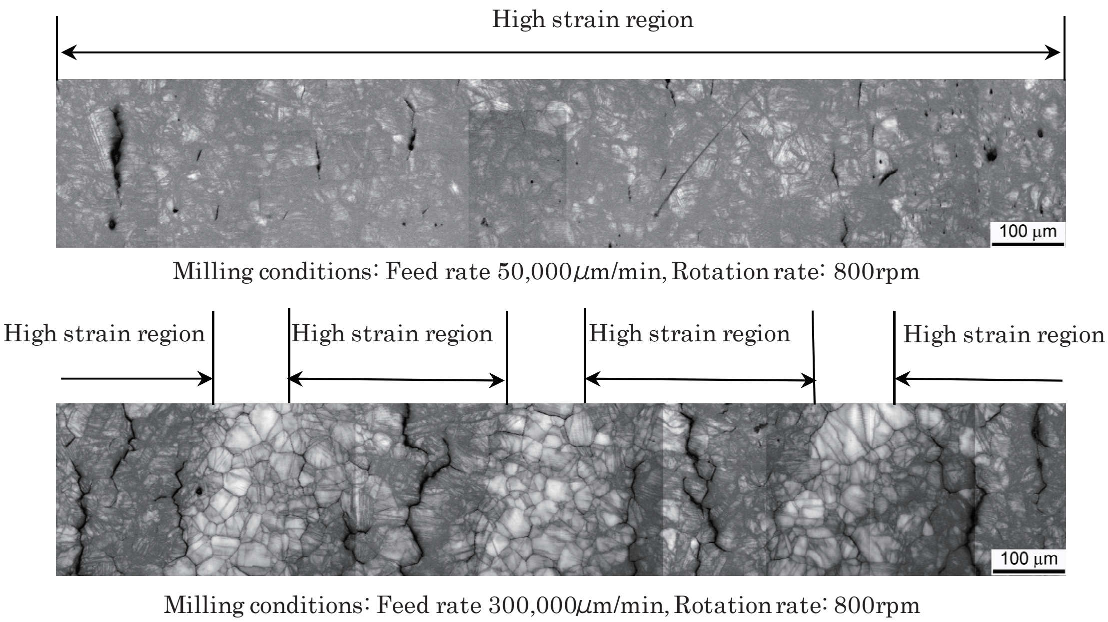

Fig.4 Distribution of plastic strain measured with electron beam diffraction and the portion of cracking

Dark parts on the image correspond to the regions of high plastic strain. Cracks tend to occur in the specimen locally strained (lower image) rather than the specimen uniformly strained (upper image).