

Influence of Stress-Induced Martensite on SCC of SUS304 in H₂SO₄-NaCl Aqueous Solution

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SUS304 stainless steel is metastable austenite and therefore when it is cold-worked, it causes partially strain-induced martensite, which is considered to affect its SCC behavior. It has been reported that strain-induced martensite introduced by U-shape bending or pre-strain plays an important role in the propagation of SCC by its preferential dissolution in H₂SO₄-NaCl aqueous solution [1]. They have explained that the martensite makes SCC path because the dissolution rate of strain-induced martensite would be larger than that of the parent austenite. However, direct comparison in the dissolution rate in such solutions between the two phases has not been carried out. In this study, therefore, the influence of strain-induced martensite on the corrosion type was examined by measuring the dissolution rate of austenite and strain-induced martensite in H₂SO₄-NaCl aqueous solutions.

Two kinds of SUS304 stainless steel specimens were used in this experiment. Their dimensions were 0.35×15×50 in mm and 2×15×50 in mm, respectively. The former specimen with 0.35 mm thickness contained 86 % strain-induced martensite by 50 % cold rolling. According to S.S.Hecher et al. [2] this amount is the maximum amount of strain-induced martensite by cold rolling. Single phase austenite specimens were prepared by annealing several of 86 %-martensite specimens at 1353 K for 1.8 ks in vacuum followed by quenching into ice water. The two kinds of specimens, 86 %-martensite and single phase austenite, were used for studying the difference in the dissolution rate between them. The test solutions were 2.5 kmol/m³ H₂SO₄ aqueous solutions containing six different concentrations of 0, 0.1, 0.2, 0.3, 0.4 and 0.5 kmol/m³ NaCl. The latter specimens with 2 mm thickness were subjected to the same heat treatment and then to cold rolling of varying degrees. The specimens thus obtained had three levels of strain-induced martensite, i.e. 7, 10 and 13 %. They were used for SCC

test in the seven different 2.5 kmol/m³ H₂SO₄ aqueous solutions containing 0, 0.1, 0.2, 0.3, 0.4, 0.5 and 0.6 kmol/m³ NaCl.

In the 2.5 kmol/m³ H₂SO₄ solutions with NaCl (0 to 0.5 kmol/m³), the apparent dissolution rates R_{cor} of 86 %-martensite specimens were larger than those of the austenite specimens. Though R_{cor} of 86 %-martensite specimen showed a simply decreasing tendency with an increase in the NaCl concentration, that of the austenite specimen showed characteristic behavior to take the maximum value for the solution with 0.2 kmol/m³ NaCl, where SCC was proved to initiate and propagate at the maximum rate. In addition, R_{cor} of 86 %-martensite specimen (A) was 14.6 times as large as that of austenite specimen(B) in the 2.5 kmol/m³ H₂SO₄ aqueous solution with 0.2 kmol/m³ NaCl, while the difference between A and B became 2.6 times in the 2.5 kmol/m³ H₂SO₄ aqueous solution with 0.5 kmol/m³ NaCl, where no SCC was proved to initiate. Considering these results, SCC is easy to initiate when strain-induced martensite exists, since SCC is supposed to be propagated by the dissolution of strain-induced martensite. The average crack propagating rate was also investigated by using the specimens containing 7, 10 and 13 % strain-induced martensite. In the 2.5 kmol/m³ H₂SO₄ solution with 0.5 kmol/m³ NaCl, the single phase austenite specimen exhibited no SCC, while all the specimens with martensite showed SCC irrespective of the amount of martensite. From these results it is confirmed that SCC is liable to occur on the specimen with martensite and that the region in which SCC occurs enlarges to the higher NaCl concentration. It was also recognized that under any conditions where SCC was initiated, the more martensite was contained, the larger the propagating rate became. The results would suggest that when SCC occurs in the conventional SUS304 products with strain-induced martensite, the environmental conditions where SCC is initiated may be enlarged, and that the crack propagation rate would increase in accordance with the increase of strain-induced martensite.

[1] T.J.Hakkarainen and A.Honkasalo: Corrosion, 32(1976),271.

[2] S. S.Hecker, M.G.Stout, K.P.Staudhammer and J.L.Smith: Metall. Trans. , 13A(1982),619.