

Localized Corrosion of Chromium Coated Steel

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Introduction

Electrolytically chromium coated steel is widely used in packaging industry [1, 2]. The chromium coating can protect carbon steel from corrosion. However, the defects in the Cr coating or the coverage of the steel surface may affect the protection. Scanning vibrating electrode technique (SVET) can be used to locate anodic and cathodic sites in coated steel using a current density mapping method [3].

In this paper, we report on the studies of the local corrosion behaviour of chromium-coated ultra low carbon steel in NaCl solution using polarization, electrochemical impedance spectroscopy (EIS) and SVET.

Experimental

The substrate is ultra low carbon steel sheet (~ 0.2 mm thick). Chromium was electroplated on the steel in a chromate bath. The Cr coatings are in different thickness: one is 0.01 µm and the other is 1.06 µm thick. The morphology of coated samples was analyzed using SEM and AFM. The corrosion resistance of these specimens in 3.5% NaCl solution was investigated using d.c. polarization and a.c. impedance measurements. The local anodic and cathodic current densities were scanned using SVET in 0.001 M NaCl solution.

Results and discussions

Polarization measurements show that the corrosion potentials of the specimens move in the positive direction with increase of the thickness of the Cr coating (see Fig. 1). The corrosion current density of the Cr-coated sheets depends also on the thickness of the coating. The specimens with a thin chromium coating (0.01 µm thick) showed a larger corrosion current density than the specimens with a thick coating (1.06 µm). It indicates that a thin chromium layer did not cover the whole steel surface. The EIS results are in agreement with these results. The SVET measurements show that three anodic sites in a small area (about 0.5×0.7 mm) have been detected. One pit initiated first and the peak of the anodic current density increased with time. After some time this current density peak became shorter and other two pits started (see Fig. 2). The surrounding area was cathodic. For the specimens with a thick chromium layer (1.06 µm) no significant defect was observed.

Conclusions

The chromium coating can improve the corrosion resistance of the ultra low carbon steel. The Cr-coated carbon steel shows a localized corrosion in NaCl solution. The corrosion resistance depends on the thickness of the Cr coating. Pitting does not initiate at all defects at the same time. The pitting

process is unstable. After a pit is covered by corrosion product a new anodic site may start to corrode.

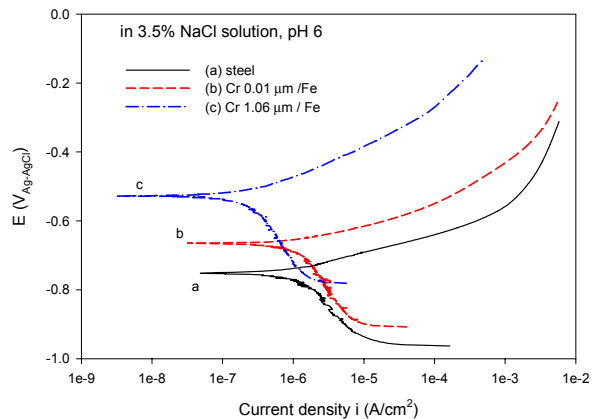


Fig. 1 Polarization curves for low carbon steel with and without Cr coating in 3.5% NaCl solution.

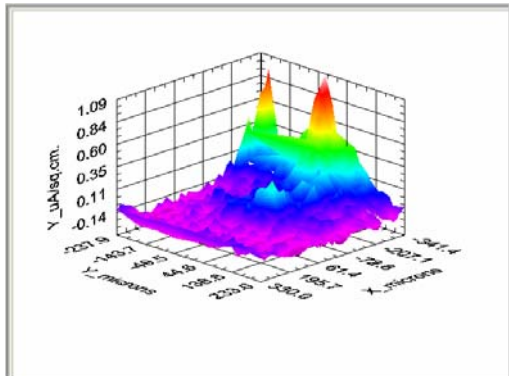


Fig. 2 (a) Current density map for the Cr-coated steel with a 0.01 µm Cr layer, obtained in 0.001 M NaCl solution for 1.5 h.

References

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