Effect of inclusions on the localized marine corrosion in low alloy steel

Chao LIU[1], Reynier I. REVILLA[2], Herman TERRYN[2], Xiaogang LI[1]

[1] *University of Science and Technology Beijing, China PR*
[2] *Vrije Universiteit Brussel, Belgium*

Inclusions in steels are considered dangerous but indispensable products of the deoxidation and desulfurization of steel and need to be removed or modified as much as possible in order to preserve the mechanical properties of the steels. As is widely known, inclusions in steel exhibit very negative impacts on its pitting resistance. Corrosion behaviour induced by different type of inclusions has been investigated, and some researchers have realized the relationship between localized corrosion and inclusions. However, the mechanism of the localized corrosion initiation process induced by inclusions was still unclear, especially in the low carbon steel. Therefore, it is of significance to probe into the localized corrosion induced by inclusions. The present work characterized the morphology of inclusions in Q460NH weathering steel by Focused Ion Beam Microscope (FIB). Stress-strain behaviour induced by inclusions was analysed by Electron Back-Scattered Diffraction (EBSD). The micro-electrochemical properties of inclusions were characterized by Current Sensing Atomic Force Microscopy (CSAFM). At last, the corrosion behaviour of pit at different stages were observed with Field Emission-Scanning Electron Microscopy (FE-SEM) after immersion test. FIB and EBSD results indicate microcrevices and high dislocation region were observed around Al_2O_3 inclusions in the cold rolling steel. However, for the rare earth modified inclusions, there were no microcrevices and high dislocation region observed around them. CSAFM result indicate inclusions in the steel exhibiting a poor conductivity. Therefore, a different mechanism from that traditionally used (considering the galvanic coupling between inclusions and matrix) to explain the pitting initiation process. After immersion test, the matrix around Al_2O_3 inclusions was selective dissolved result from the existence of microcrevices and high dislocation region. The catalytic-occluded cells and oxygen-concentration cell could accelerate the propagation of the pits. Meanwhile, for the rare earth modified inclusions, the main reason for the pitting corrosion was the dissolution of $(RE)_2O_2S$-(RE)xSy in the solution. The initial pits formed with the dissolution of $(RE)_2O_2S$-(RE)xSy, and the catalytic-occluded cells and oxygen-concentration cell could also accelerate the propagation of the pits.

Keywords: Carbon steel, Inclusion, Pitting corrosion, CSAFM, EBSD