

## **pH-dependent passivation mechanisms of Cr and Mn in stainless steel under acidic conditions**

**Kaiping YU**<sup>1</sup>, Mingxin HUANG<sup>1</sup>

*<sup>1</sup>Department of Mechanical Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong, China*

*kpyu20@hku.hk*

**Abstract** The passivation behavior of Cr and Mn in stainless steel was investigated in acidic environments with varying pH values by controlling the concentrations of Na<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>SO<sub>4</sub>. It was found that the passivation sequence of Cr and Mn was dependent on the solution pH, which diverged from the predictions made by the Eh-pH diagrams calculated using Nernst equations. Through experimental correction, the critical pH for the passivation sequence was determined as ca. 3.2.

In addition, the passivation mechanisms of the Mn-based secondary passivation differed across the critical pH threshold. Above this point, Mn passivation primarily occurred through the migration and oxidation of Mn atoms and cations that diffused outward from the steel matrix. In contrast, below the critical pH, the deposition of Mn from Mn ions in the solution becomes the dominant mechanism for secondary passivation. These Mn ions, which dissolve due to the transpassivity of Cr occurring around 1100 mV, such as Mn<sup>2+</sup> and Mn<sup>3+</sup>, were selectively oxidized as the potential increased.

**Keywords** Stainless steel, chromium, manganese, pH-dependent, passivation sequence