

Development of Iridium Oxide Sensor for Surface pH Measurement of a Corroding Metal under Deposit

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A novel method used to design and fabricate a pH sensor for measurement of hydrogen ion activity on corroding metal surface in under deposit. The electrodeposition method of cyclic voltammetry approach is used for coating of Iridium Oxide (IrO_x) on stainless steel substrate. The pH value of the X52 carbon steel under deposit (agar) was monitored for the first time using the in-situ iridium oxide pH probe during the CO₂ corrosion at 25 and 80°C. Cyclic voltammetry (CV), field emission scanning electron microscopy (FESEM), energy-dispersive X-ray spectroscopy (EDX), Linear polarization resistance (LPR), and open circuit potential (OCP) were used for CO₂ corrosion and iridium oxide film characterization. The fabricated pH sensor was calibrated by using a commercial glass pH probe. The response of electrodeposited IrO_x electrodes to exposure to a series of universal buffer solutions depicts a linear super-Nernstian response resulting in a sensitivity of -77.18 mV/pH for combination of three IrO_x pH sensors. The pH response measured by OCP at 25 °C was 75.3 mV/pH units. The pH of metal surface under deposit increased gradually up to pH=8 after exposure in CO₂-saturated 3% NaCl solution compared to the bulk solution pH (pH=6). Results demonstrated the proposed pH sensor design can be used for real-time corrosion monitoring by surface pH measurement. The design approves that the measurement was able to determine the pH changes under agar, which is a critical requirement for studying corrosion under deposit. In all cases, metal surface pH under deposit increased compared with bulk solution pH after the corrosion process began. These findings indicate that IrO_x pH sensor material can be changed to any other sensing material which is very useful for monitoring of MIC or other kind of corrosion.

Keywords: IrO_x pH sensor; Electrodeposition method; Surface pH measurement; Cyclic voltammetry

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