

Accepted Manuscript

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PII: S1572-6657(17)30638-0
DOI: doi: [10.1016/j.jelechem.2017.09.016](https://doi.org/10.1016/j.jelechem.2017.09.016)
Reference: JEAC 3510

To appear in: *Journal of Electroanalytical Chemistry*

Received date: 11 May 2017
Revised date: 6 September 2017
Accepted date: 8 September 2017

Please cite this article as: Ming Liu, Xuequn Cheng, Xiaogang Li, Tian Jian Lu , Corrosion behavior of low-Cr steel rebars in alkaline solutions with different pH in the presence of chlorides, *Journal of Electroanalytical Chemistry* (2017), doi: [10.1016/j.jelechem.2017.09.016](https://doi.org/10.1016/j.jelechem.2017.09.016)

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Corrosion behavior of low-Cr steel rebars in alkaline solutions with different pH in the presence of chlorides

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Abstract: Corrosion behaviors of HRB400 carbon steel and three low-Cr steel rebars in alkaline solution simulating concrete pore solution with various pH and chlorides values were studied using cyclic voltammetry, potentiodynamic polarization, electrochemical impedance spectroscopy, and Mott-Schottky combined with scanning electron microscope as well as X-ray Diffraction. Results show that pH and chloride play important roles in the formation of passive films on steel rebars. As pH value decreased, the pitting potential shifts negatively, the polarization resistance decreases while the density of current carrier in the passive film increases. In the absence of chloride, stable passive film cannot form on carbon steel in simulated concrete pore solution with pH 9.6, Cr³⁺ cannot remain stable in the passive film on 3Cr and 5Cr steel, and passive film on low-Cr steels are more stable than that of carbon steel. While pitting corrosion is promoted by increasing chloride ions, Cr effectively reduces pitting propagation, resulting in the high passivation capability of steel rebar in carbonated concrete pore solution. The corrosion products of carbon and low-Cr steels have common characteristics, with Cr accelerating the formation of protective α -FeOOH and lowering the corrosion rate. Therefore, Cr-modified steel presents excellent passive behavior and pitting corrosion resistance in simulated carbonated concrete pore solution, which can be further enhanced by increasing the Cr content.

Keywords: pH, Low Cr steel, Cyclic voltammetry, Passive film, Mott-Schottky

1. Introduction

Chlorides and carbonation of concrete are the primary reasons for the failure of reinforced concrete structures [1–4]. Moreover, the pH of concrete pore solution is usually associated with the stability of passive film on rebars. Whereas passive film on carbon steel (CS) rebars is stable

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