The corrosion behavior of 316 stainless steel under the cooperative effect of plastic stress and UV illumination in 3.5 wt% NaCl solution

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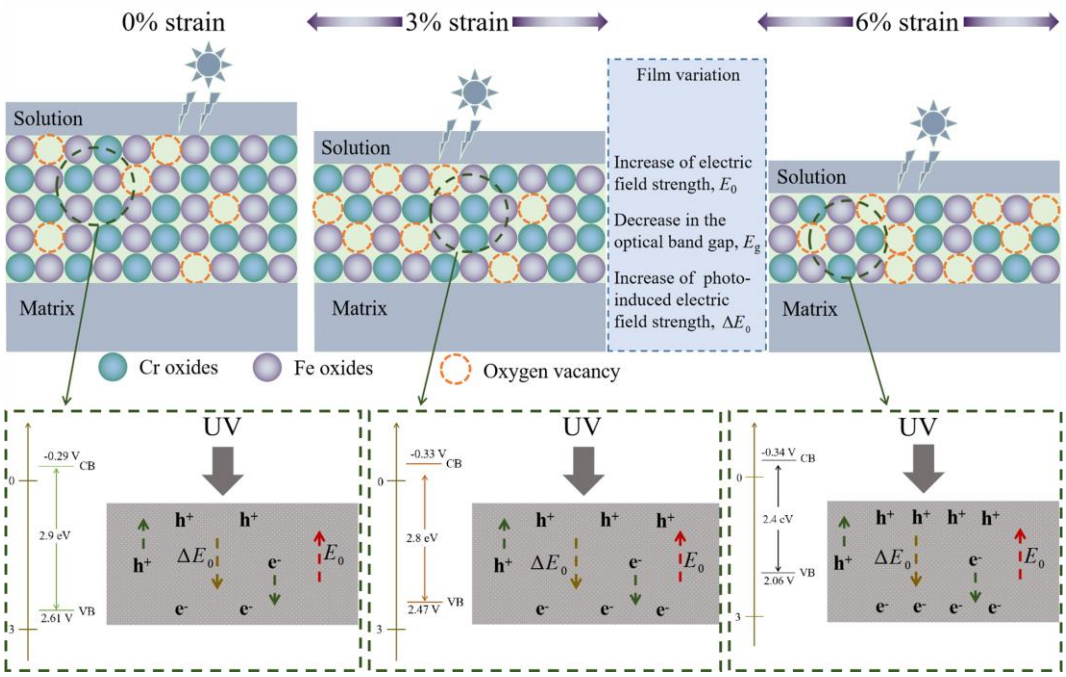
Abstract When in service in the marine environment, support structure components, which are critical components of offshore equipment, are susceptible to a combination of strong irradiation and the tensile stresses that the material itself is subjected to during service, which can lead to severe corrosion of the material. Previous analysis has shown that both plastic tensile stress and UV illumination affect the properties of semiconductors and the composition of passive films, implying that there may be an interaction between the two factors. However, up to now, no detailed investigation of the effect of the interaction of stress and UV illumination on the corrosion behavior of stainless steel has been reported.

Therefore, to analyse the corrosion behaviour of metals under the combined effect of stress and illumination, we conducted an in-depth study on the passive film of 316 stainless steel under the combined effect of plastic tensile stress and UV illumination, as well as the pitting corrosion behaviour after film rupture.

The results showed that the pitting corrosion resistance of the film deteriorates under the combined effect of both factors. Among them, illumination improves film stability by decreasing the potential drop at the film/solution interface, the donor density, the intensity of the electric field within the film, and increasing the Cr2O3 content within the film. The plastic tensile stress not only increases the corrosion rate by increasing the defect density but also enhances the photo-induced electric field strength and photocurrent density by decreasing the band gap value and increasing the flat band potential.

Keywords: illumination; Electrochemical characterization; Plastic tensile stress.



Schematic of corrosion of the passive film formed on 316 stainless steel under stress and illumination

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