In-situ synchrotron x-ray reflectivity studies of the passive oxides formation on iron and Fe-Cr alloy

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ABSRACT

The passivation kinetics of iron and Fe-16.31%Cr alloy in pH 8.4 borate buffer solution was investigated by means of *in situ* x-ray reflectivity. During the cathodic pretreatment at –1.5V (vs. $E_{Ag/AgCl}$) the air-formed oxide film on iron was removed completely, while the oxide film on Fe-Cr alloy was not reduced fully (d = 23.4±0.8 Å). The growth of the passive oxide on iron and Fe-Cr alloy under several potentiostatic conditions were measured by *in situ* specular x-ray reflectivity in real time (Fig. 1). The quasi steady-state saturation thickness varies according to the applied potentials as illustrated in Fig. 2. In the case of iron, the saturation thickness changed linearly upon increasing the anodization potentials in the passive region. On the other hand, Fe-Cr alloy had two linear regions divided near the potential where the transpassive behavior of Fe-Cr alloy starts due to the dissolution of Cr oxide. The Cr dissolution was evident from the change of chemical compositions measured by anomalous x-ray reflectivity measurements. All data were compared to two different theoretical predictions of the passive film growth, namely the high field model[1-3] and the point defect model[3,4]. All x-ray reflectivity curves were analyzed in the Parratt's formalism[5].

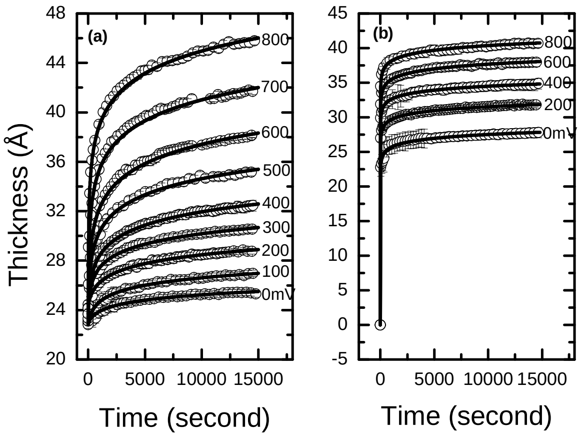

Figure 1. The oxide thickness of the passive film on (a) Fe-Cr alloy and (b) pure iron are plotted as a function of the passivation time and for different applied potentials. Solid lines are the fit results.

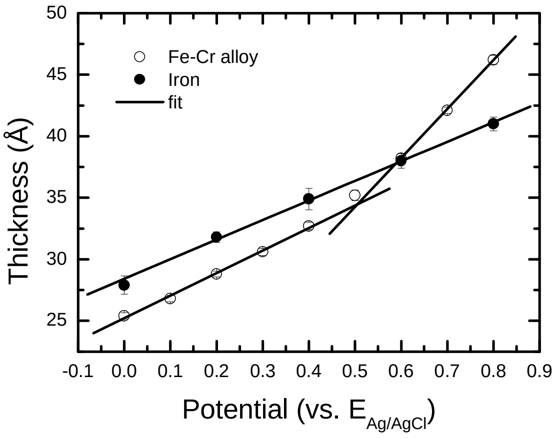

Figure 2. The quasi steady-state saturation thickness is plotted vs. the potentials.

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