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GISAXS of pre-crystallisation events in the formation of CO₂ corrosion products on steel

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The corrosion of steel in aqueous saturated CO₂ environments is a major industrial problem. Under certain conditions a highly protective scale of siderite (FeCO₃) is formed; however, there is little information available regarding the initial nucleation processes. In recent years we have performed a number of in situ synchrotron X-ray diffraction studies using electrochemistry to accelerate the corrosion rate, exploring the effect of temperature [1], corrosion inhibitor species and concentrations [2-3], addition of Mg²⁺ [4] and Cr³⁺ [5], and steel microstructure [6] on the growth rates of crystalline FeCO₃ films. These experiments all showed a significant induction period before a signal was observed. Recently we used grazing incidence small-angle X-ray scattering (GISAXS) and obtained evidence for an amorphous gel film that forms at much shorter times [7]. Our current hypothesis is that this amorphous gel then crystallises into either chukanovite (Fe₂(OH)₂CO₃) or siderite, possibly via amorphous chukanovite as an intermediate phase.

[1] Ingham, Ko, Kear et al., *Corr. Sci.* 52 (2010) 3052.

[2] Ko, Laycock, Ingham & Williams, *Corrosion* 68 (2012) 1085.

[3] Ko, Laycock, Ingham & Williams, *NACE Int. Corrosion Conf. Ser.* 5 (2012) 3662.

[4] Ingham, Ko, Laycock et al., *Corr. Sci.* 56 (2012) 96.

[5] Ko, Ingham, Laycock & Williams, *Corr. Sci.* 80 (2014) 237.

[6] Ko, Ingham, Laycock & Williams, *Corr. Sci.* 90 (2015) 192.

[7] Ingham, Ko, Kirby, Laycock & Williams, *Faraday Discuss.* In press (2015). DOI: 10.1039/C4FD00218K.

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Primary author(s) : Dr INGHAM, Bridget (Callaghan Innovation)

Co-author(s) : Prof. WILLIAMS, David (University of Auckland); Dr KO, Monika (Quest Integrity Group); Dr LAYCOCK, Nick (Qatar Shell Research & Technology Centre)

Presenter(s) : Dr INGHAM, Bridget (Callaghan Innovation)

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