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Magnetic force microscopy as a phase characterisation technique in stainless steels

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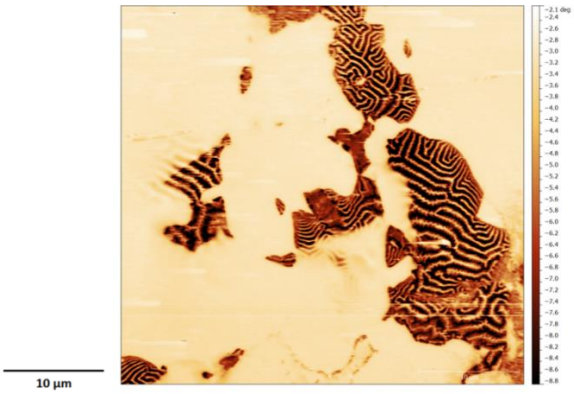
Abstract

Austenitic and duplex stainless steels contain a mix of austenite and ferrite, with the relative proportions of these phases, and their relative spatial distribution, significantly affecting the engineering properties, thermal ageing behaviour and creep damage accumulation. Given these effects, the ability to map the distribution of phases in a steel at approximately 10 nm resolution or better is of great interest. In these steels the two phases have different magnetic properties since austenite is paramagnetic and ferrite is ferromagnetic so that their distributions can be mapped using magnetic force microscopy (MFM). In this talk we discuss the application of MFM to image and quantify the distribution and proportion of ferrite in SAF 2205 duplex steel and a AISI Type 316H austenitic stainless steel. These results are compared directly with maps recorded in the same regions using the established phase mapping technique of electron back-scatter diffraction (EBSD); including a comparison of mapping resolution and quantification methods. For the quantification to be effective, a knowledge of the relative surface penetration of the two techniques is required. Then through the use of surface shielding it has been possible to quantify the depth measurement of the MFM system used in steel as 105 to140 nm.



MFM magnetic image showing the distribution of ferrite in thermally aged 2205 duplex stainless steel. The cream regions are austenite and the brown/black regions ferrite. The striations in the brown colouring correspond to the magnetic field lines