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Microstructural characterisation during precipitation in superaustenitic stainless steels

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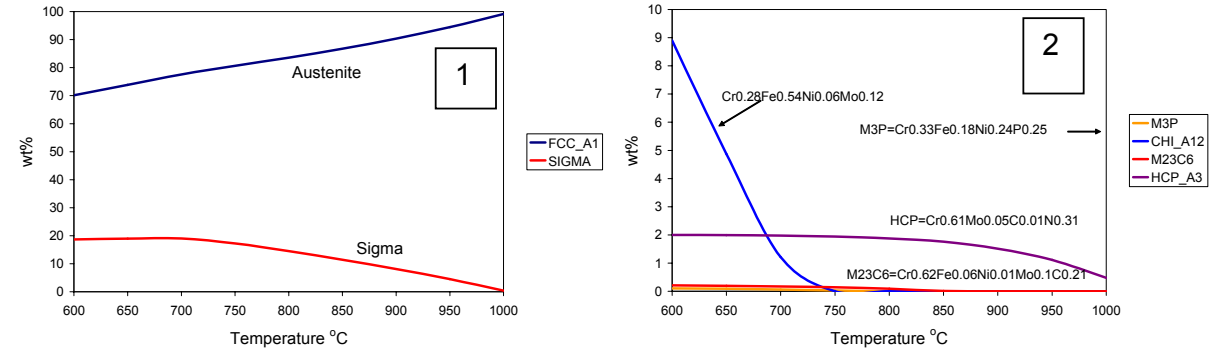
Superaustenitic stainless steels with combined high chromium and molybdenum additions have excellent pitting corrosion resistance in a marine environment [1]. This behaviour is coupled with high strength and excellent ductility, making these grades natural candidate materials for marine applications.

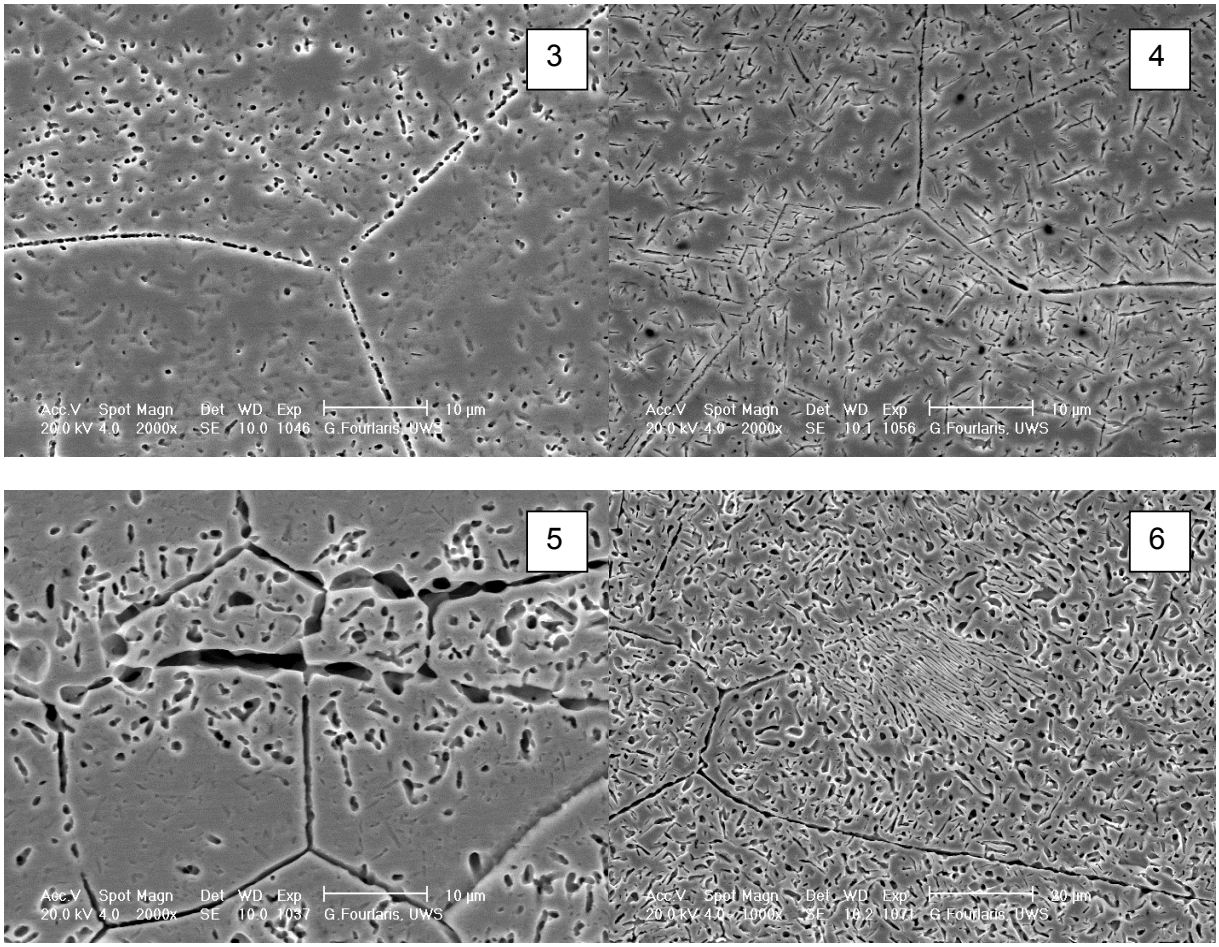
The purpose of the present study is to assess the microstructural stability and the associated effects on the mechanical properties of two novel superaustenitic grades (254SMO and 654SMO) during ageing experiments performed within the temperature region of 650-950^{o}C for various periods of time, ranging from 5mins to 240h. The microstructures obtained were characterised via SEM microscopy coupled with EDS microanalysis, XRD phase identification and hardness testing. Due to the complexity of the possible parallel precipitation reactions occurring, the use of MT-DATA (thermodynamic modelling software) has been made to facilitate the prediction of the presence of expected precipitate species, under equilibrium conditions.
These thermodynamic predictions for the major phases and the minor phases expected to be present, as a function of the ageing temperature applied (under equilibrium conditions) are presented in figures 1 and 2, for one of the superaustenitic grade studied (254 SMO).

It has been confirmed that the novel superaustenitic grades are prone to complex phase transformations during the ageing experiment performed. For ageing at 750^{o}C and 850^{o}C the formation of χ and σ phases took place for samples that were aged between 24h and 240h. As a result of these complex phase transformations within austenite, significant hardening of the austenitic matrix is confirmed throughout the ageing temperature range (650-950^{o}C) employed. Most interestingly, although the microstructures studied by SEM for samples aged at 750 and 850^{o}C appear similar in terms of the obtained constituents (Figs 3-6), careful SEM imaging coupled with XRD phase characterisation identified the presence of variable amounts of precipitate volume fractions and species forming on the two superaustenitic grades studied.
The results confirmed that for short ageing experiments the microstructural stability of the superaustenitic grades studied was confirmed at all ageing temperatures studied. However, prolonged ageing exposure results into formation of σ and χ phases (in variable amounts for each grade studied) within the temperature region of 750- 950^{o}C, with consequential effects on the mechanical and corrosion characteristics of the superaustenitic grades studied.

References

1. S. Nana and M.B. Cortie: Metallurgical and Materials Transactions A, Vol. 27A, pp. 2436-2444, 1996.





Figs.1 and 2: MT-DATA thermodynamic predictions of the equilibrium phases (major phases-fig.1 and minor phases-fig.2) of the 254SMO superaustenitic grade at various ageing temperatures.
Figs. 3 and 4: Secondary SEM micrographs of superaustenitic samples aged at 750 for 240h (fig 3-254 SMO, fig.4 - 654SMO).
Figs. 5 and 6: Secondary SEM micrographs of superaustenitic samples aged at 850 for 120h (fig 5-254 SMO, fig. 6 - 654SMO).

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