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Comparative analysis of the microstructure and sensitization susceptibility of CA6MN and F6NM martensitic stainless steels

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Introduction

Supermartensitic stainless steels are widely used in several industrial sectors. The F6NM grade of ASTM A182 corresponds to the UNS S41500 steel and the CA6NM of the ASTM A743 corresponds to the UNS J91540 specification. They have similar compositions but quite different processing routes. The F6NM is forged and the CA6NM is cast, and both have low carbon, ~12%Cr, ~4.5%Ni and 0.5-1.0%Mo. The double loop electrochemical potentiondynamic reactivation (DL-EPR) test is reported in the literature with certain parameters showing a good correlation with microstructural characterization [1-2].

Objectives

The purpose of this work was to evaluate the influence of heat treatment parameters on microstructure and sensitization susceptibility of two similar supermartensitic stainless steels, F6NM and CA6NM.

Methodology

Table 1: Chemical compositions of CA6NM and F6NM studied.

Steel	C	Cr	Ni	Mo	Mn	S
CA6NM	**0.060**	12.5	4.01	0.59	0.80	0.005
F6NM	**0.025**	12.8	3.86	0.64	0.56	0.002

Table 2: Heat treatments performed in CA6NM and F6NM steels.

Heat treatment	Descripition
Q	Quenching – 1000°C/1h, water cooling
QT-500	Q + Tempering at 500°C
QT-525	Q + Tempering at 525°C
QT-550	Q + Tempering at 550°C
QT-575	Q + Tempering at 575°C
QT-600	Q + Tempering at 600°C
QT-625	Q + Tempering at 625°C
QT-650	Q + Tempering at 650°C
QT-675	Q + Tempering at 675°C
DT	Q + Double Tempering (670°C/2h + 620°C/2h)

- **DL-EPR** tests - degree of sensitization (DOS = Ir/Ia). Two solutions: 0.25MH_2SO_4 + 0.01MKSCN and 0.125M H_2SO_4+0.01MKSCN.
- Microstructures were observed in specimens etched with Villela's reagent and after the DL-EPR
- Austenite volume fractions (AVF) measured by X-ray diffraction.

Results e Discussion

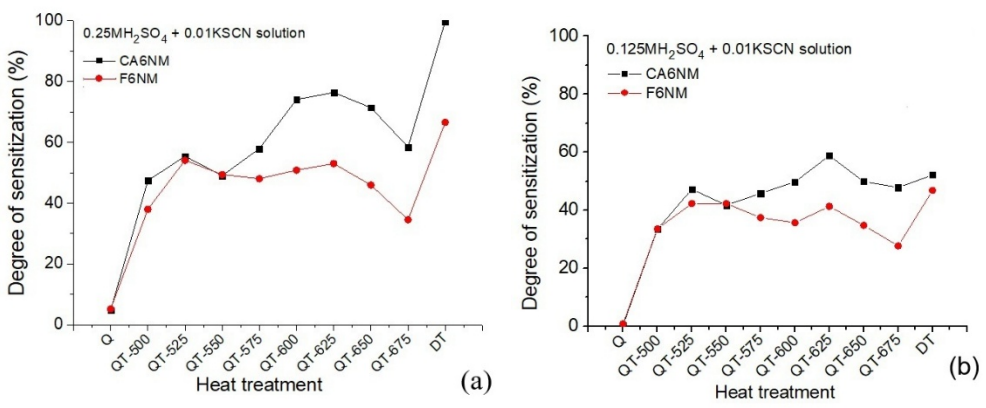

Fig. 1. Degree of sensitization in different heat treatments: (a)0.25M H_2SO4+0.01KSCN; (b)0.125M

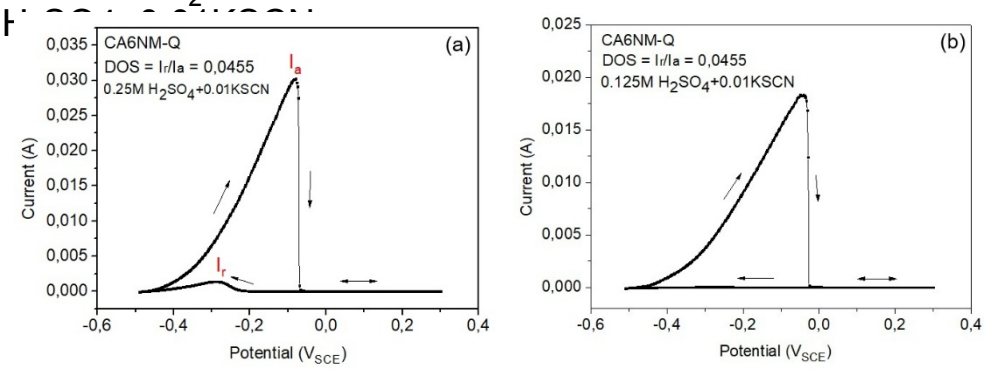

Fig.2. DL-EPR curves of specimen CA6NM-Q: (a)0.25M H_2SO4+0.01KSCN; (b)0.125M H_2SO4+0.01KSCN

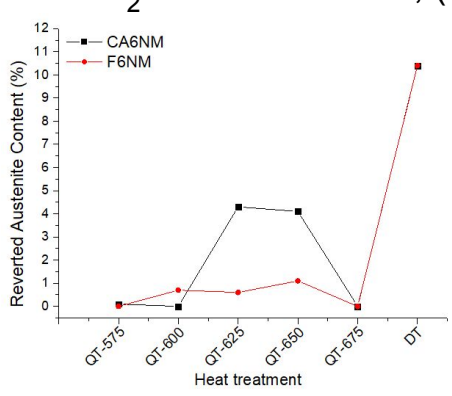

Fig.3. Variation AVF with heat treatment

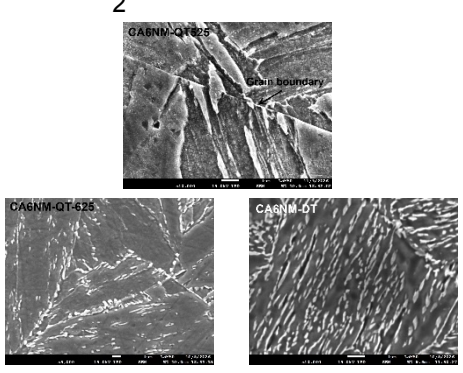

Fig.4. Microstructures of CA6NM (QT-525, QT-625, DT)

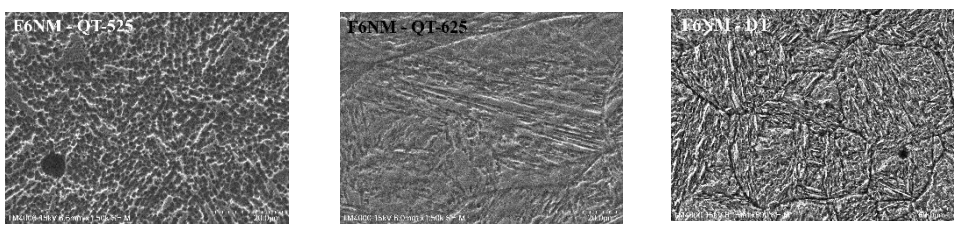

Fig.3. Microstructures revealed by the DL-EPR test.

Conclusions

- Solution 0.125M H_2SO4+0.01KSCN was better for F6NM and CA6NM than 0.25M H_2SO4+0.01KSCN.
- CA6MN was more susceptible to sensitization than F6NM, probably due its higher %C.

References and Acknowledgement

1. CALDERÓN-HERNÁNDEZ, J. W.; HINCAPIE-LADINO, D.; FILHO, E. B. M.; MAGNABOSCO, R.; ALONSO-FALLEIROS, N.. Relation Between Pitting Potential, Degree of Sensitization, and Reversed Austenite in a Supermartensitic Stainless Steel. CORROSION, vol. 73, no 8, p. 953–960, ago. 2017. DOI 10.5006/2311. Disponível em: http://corrosionjournal.org/doi/10.5006/2311.
2. DA SILVA, G. F.; TAVARES, S. S.M.; PARDAL, J. M.; SILVA, M. R.; DE ABREU, H. F.G. Influence of heat treatments on toughness and sensitization of a Ti-alloyed supermartensitic stainless steel. Journal of Materials Science, vol. 46, no 24, p. 7737–7744, 2011. https://doi.org/10.1007/s10853-011-5753-8.
3. ČIHAL, V., A Potentiokinetic reactivation method for predicting the I.C.C. and I.G.S.C.C. sensitivity of stainless steels and alloys, Corrosion Science 20 (1980) 737-744.

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