cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

Effects of aging heat treatment on microstructure, corrosion resistance and hardness of superduplex stainless steel UNS S39274 cold-deformed to 125 ksi grade

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Introduction

Superduplex stainless steels (SDSS) are biphasic Fe-Cr-Ni alloys widely used in the oil and gas industry due to their high corrosion resistance. Between 300 and 1000 °C, as in welding or hot forming, deleterious phases such as sigma (σ), Chi (χ) and nitrides may precipitate in ferrite, depleting chromium and impairing corrosion resistance.

Objective

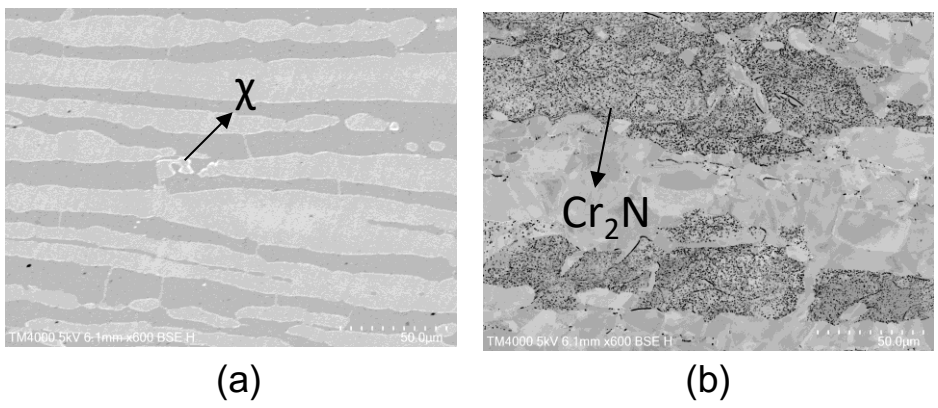
To investigate the effects of aging on the microstructure, hardness and corrosion resistance of the cold-deformed SDSS UNS S39274, 125 ksi grade.

Methodology

Samples in the as-received condition and aged at 600 °C for 2 h and 800°C for 15 min were characterized by SEM, with and without 10% oxalic acid etching, EDS, digital image processing (DIP) and ferritoscopy (FS). Vickers hardness and phase microhardness were measured, and corrosion resistance was evaluated by DL-EPR testing.

Sample	Ferrite FS (%)	Ferrite DIP (%)	χ DIP (%)	Hardness (HV)
AR	43.16	46.1	–	306 ± 4.6
600ºC-2h	40.23	43.9	1.3	312 ± 3.6
800ºC-1/4h	37.62	43.0	3.9	292 ± 1.7

Table 1. Phase fractions and microhardness.



(a) (b)

Figure 1. SEM of the 800ºC-1/4h sample (a) without and (b) with oxalic acid etching.

Results and Discussion

All aged samples showed χ precipitation from 600 °C (Table 1). Deleterious phases formed at the expense of ferrite, and Cr_2N nitrides were more expressive at 800 °C (Figure 1). EDS revealed chromium depletion in ferrite. Hardness did not vary significantly (Table 1), which was attributed to tungsten.

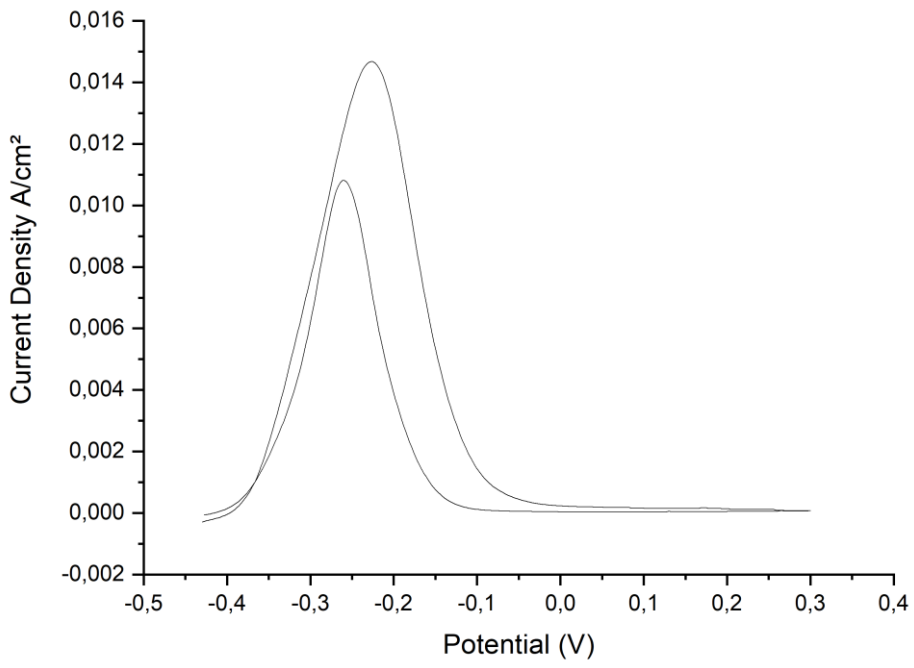
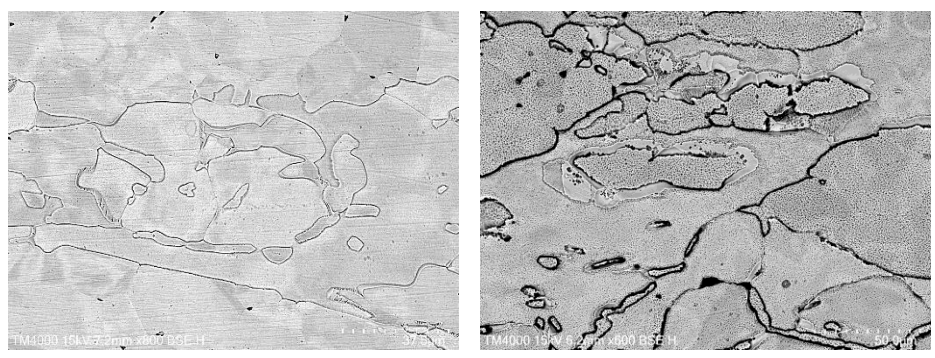


Figure 2. DL-EPR curve (800ºC-15 minutes).



(a) (b)

Figure 3. SEM after DL-EPR (a) AR, (b) 800ºC-1/4h.

The sample aged at 800 °C for 1/4 h showed the greatest reduction in corrosion resistance (Figures 2 and 3), associated with higher fractions of χ and nitrides.

Conclusions

Aging promoted χ precipitation from 600 °C, hardness was not affected by the deleterious phases, and aging at 800 °C reduced corrosion resistance.

References and Acknowledgments

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This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.