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Influence of copper addition to 2205 duplex stainless steel heat treated at 600ºC

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Introduction

- Duplex stainless steels (DSSs) are widely used due to its excellent combination of pitting corrosion resistance and mechanical strength [1,2].
- These properties depend on the chemical composition and microstructural control. Copper (Cu) additions can promote austenite formation and precipitation, contributing to increased hardness and improved material properties [3].
- In this context, investigating the effects of different Cu contents on the microstructure and corrosion resistance of these steels is particularly relevant, especially after heat treatments at 600 °C, a temperature that may be employed for stress relief in welded joints.

Objective

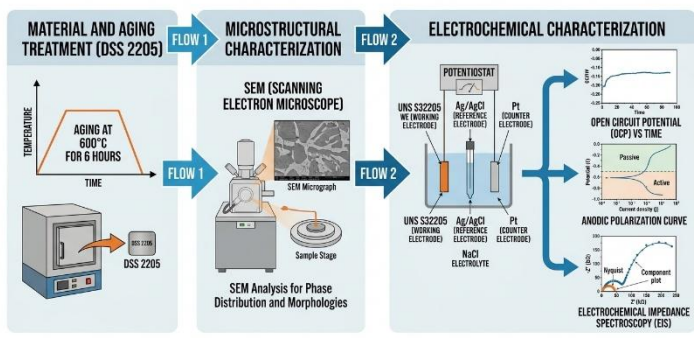
- To evaluate the influence of copper additions (1, 1.5, 2, and 3 wt.%) on the microstructure, hardness, and pitting corrosion resistance of duplex stainless steels subjected to heat treatment at 600 °C.

Methodology

Table 1 - Chemical composition of the steels (wt.%)

Alloy	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
0Cu	0.026	1.26	0.028	0.003	0.470	22.020	5.370	2.890	0.24
1Cu	0.026	1.24	0.028	0.003	0.465	22.020	5.370	2.860	0.79
1.5Cu	0.025	1.22	0.027	0.003	0.459	22.020	5.370	2.820	1.65
2Cu	0.025	1.21	0.027	0.003	0.452	22.020	5.370	2.780	2.13
3Cu	0.025	1.19	0.027	0.003	0.446	22.020	5.370	2.740	3.18

Figure 1 - Experimental method



Results

Figure 2 - SEM micrographs of samples with different Cu contents: (a) 1.0%; (b) 1.5%; (c) 2.0%; and (d) 3.0

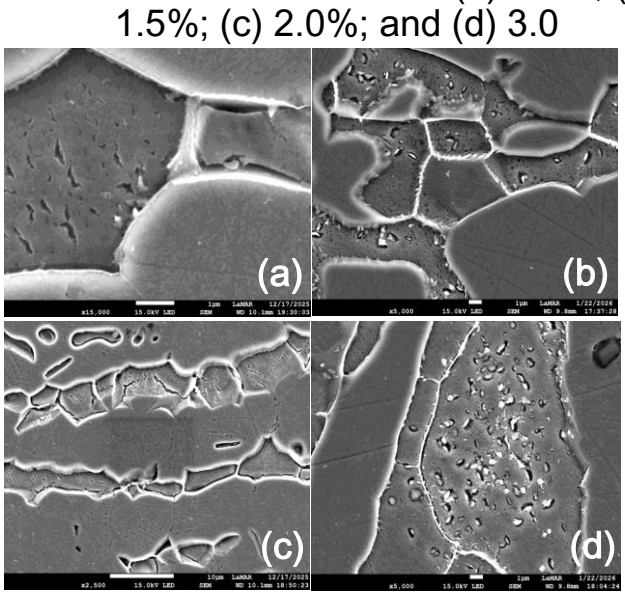


Figure 3 – Phases microhardness

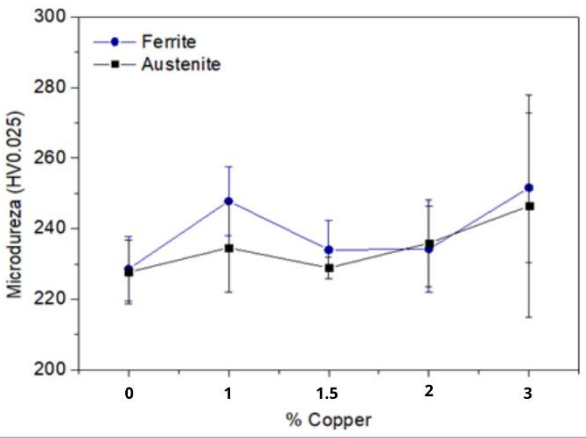


Figure 4 - Open-circuit potential behaviour of the alloys tested

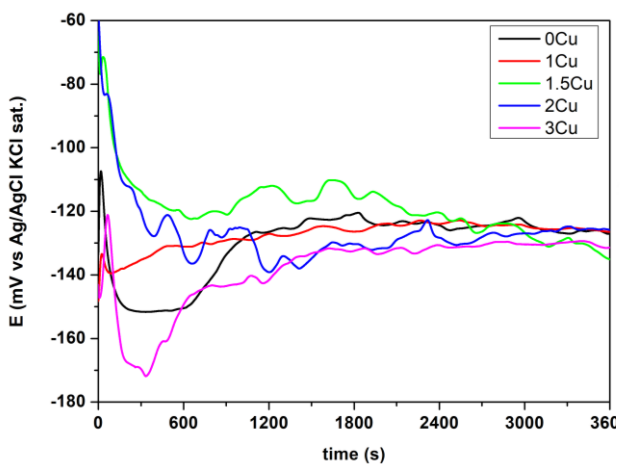


Figure 5 - Polarisation responses of the alloys tested

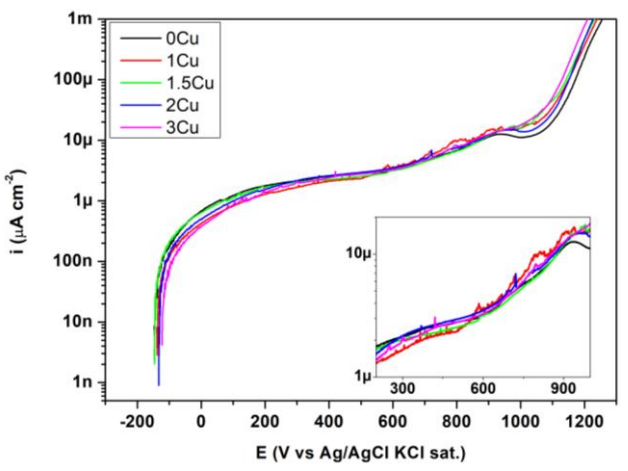
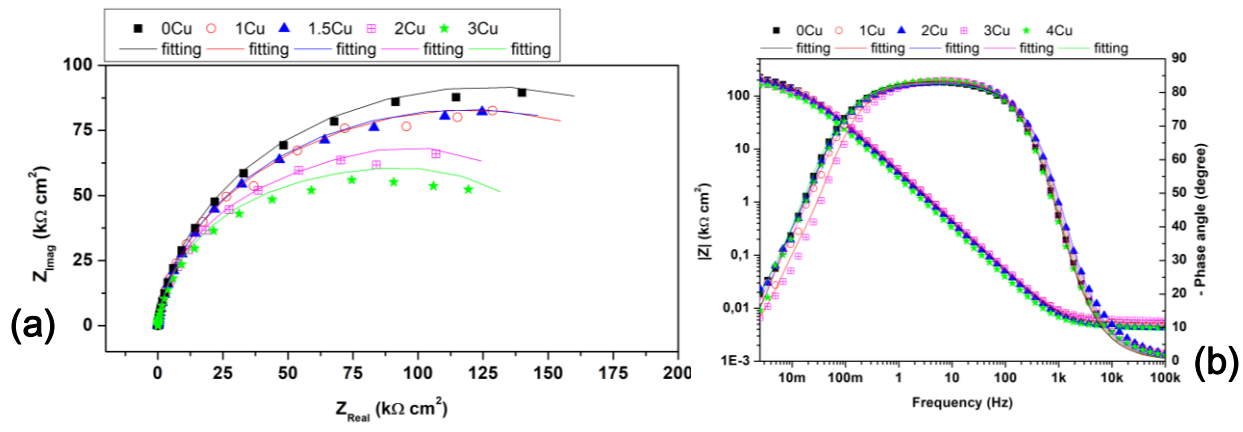


Figure 6 - EIS results (a) Nyquist and (b) Bode plots



Conclusions

- Cu addition increased the austenite fraction and hardness, reaching 290 HV1 with 3 wt.% Cu.
- Despite these microstructural changes, pitting corrosion resistance was not significantly affected.
- The R phase was observed in all alloys, while Cu-rich precipitates were detected only in the 3 wt.% Cu alloy.

[1] DE LIMA, H.M.L.F. et al. J. Mater. Eng. Perform., 32 (2023) 5980-5997
[2] DE LIMA, H.M.L.F. et al. J. Mater. Eng. Perform., 28 (2019) 2421-2426
[3] ZHOU, K. *et al.* Steel Res. Int. (2026) e70623.

Acknowledgments
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