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Sensitization of forged supermartensitic stainless steel UNS S41426

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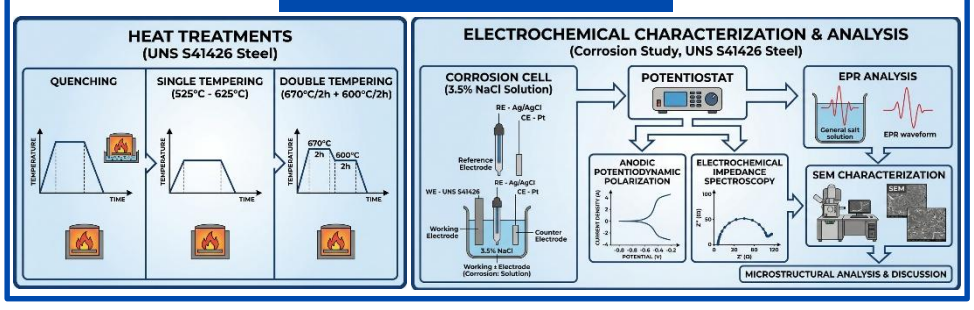
Introduction

Supermartensitic stainless steels of type UNS S41426 are corrosion resistant alloys typically produced as seamless hot-rolled tubes or large forged pieces for application in oil country tubular goods (OCTG) systems [1]. Pipes and mandrels of SMSS are assembled in the production column and casings of gas and oil wells. Due to the relatively low cost in relation to duplex/superduplex steels and nickel alloys, the SMSSs are applied in environments with high chloride concentration, CO_2 and moderate H_2S partial pressure [2]. After forging or hot rolling, the SMSSs parts must be properly quenched and tempered, or double tempered, in order to adjust mechanical properties. The parameters of these heat treatments strongly determine the microstructure and corrosion resistance of the steel [3].

Objectives

To investigate the effect of heat treatments (quenching, double tempering, and tempering) on the electrochemical behavior of UNS S41426 supermartensitic stainless steel in NaCl solution

Methodology



Results

Figure 1 - SEM micrograph of the steel in the QT-625 condition.

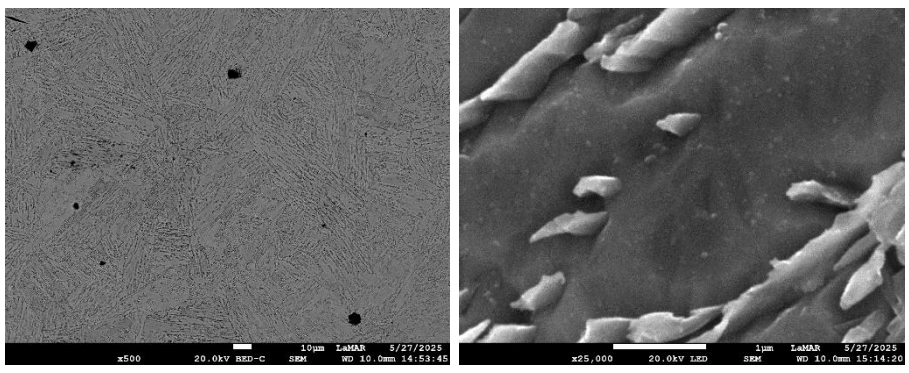


Table 1 - Summary of the microstructural features identified in the investigated specimens.

Specimen	Microstructural features
Q	Fresh martensite + TiN coarse particles
QT-575	Tempered martensite + TiN coarse particles
QT-625	Tempered martensite + TiN coarse particles + reverse austenite (3,7%)
QT-DT	Tempered martensite + TiN coarse particles + revese austenite (14,1%)

Figure 2 - Current density versus potential curves from DL-EPR tests, highlighting the activation (Ia) and reactivation (Ir) peaks.

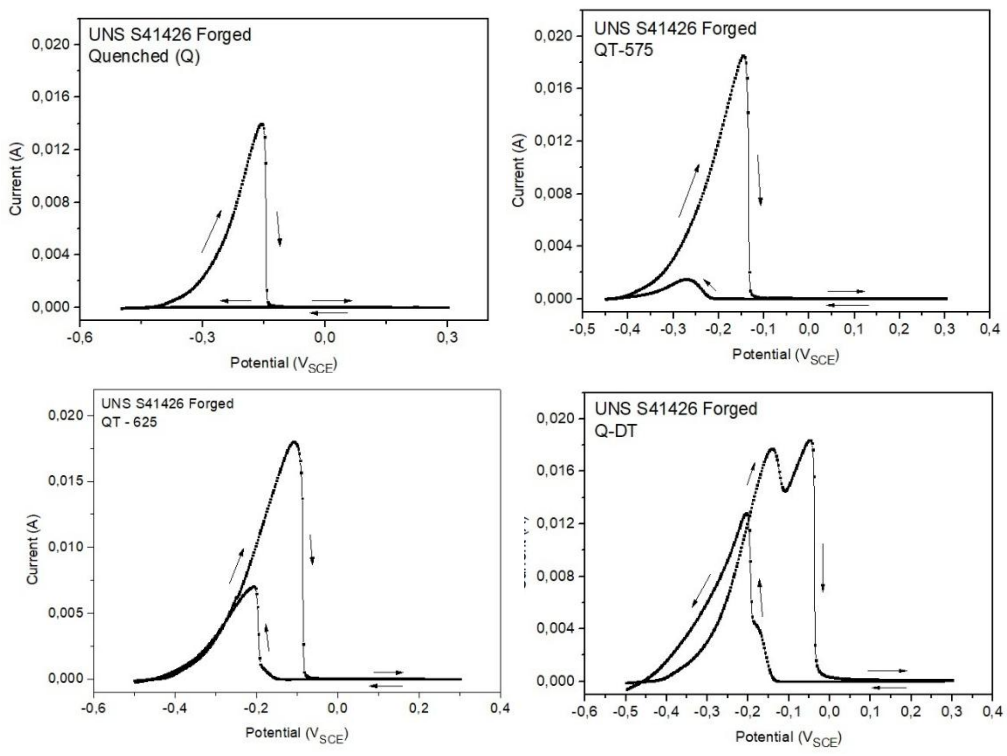


Figure 4 – (a) Nyquist and (b) Bode diagrams.

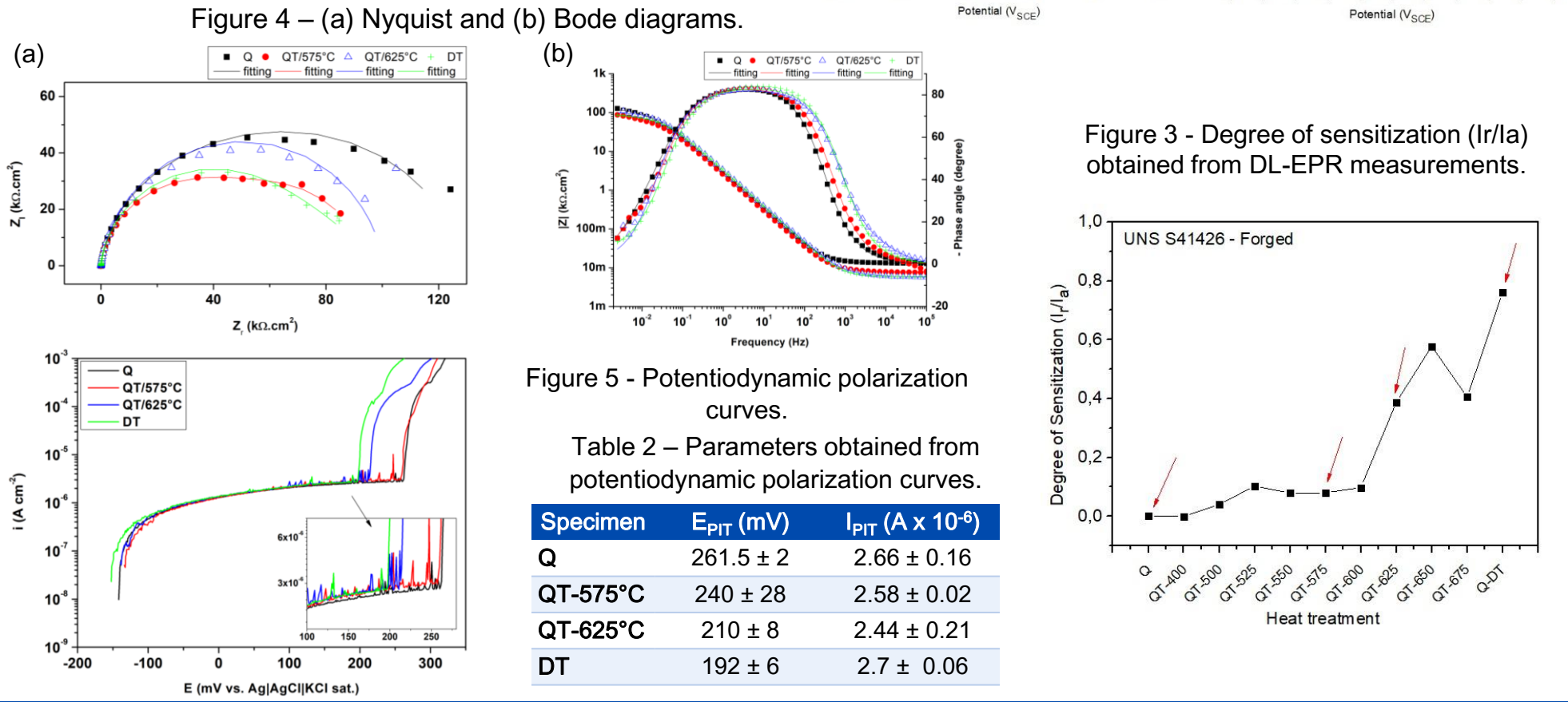


Figure 5 - Potentiodynamic polarization curves.

Table 2 – Parameters obtained from potentiodynamic polarization curves.

Specimen	E_{PIT} (mV)	I_{PIT} (A x 10^{-6})
Q	261.5 ± 2	2.66 ± 0.16
QT-575°C	240 ± 28	2.58 ± 0.02
QT-625°C	210 ± 8	2.44 ± 0.21
DT	192 ± 6	2.7 ± 0.06

Figure 3 - Degree of sensitization (Ir/Ia) obtained from DL-EPR measurements.

Conclusions

The degree of sensitization (DOS) increased with the tempering temperature up to 650 °C in specimens quenched and single tempered, and decreased in the sample tempered at 675ºC. The DOS was maximum in the specimen Q and DT, which can be attributed to the high content of reverse austenite in this sample. Anodic polarization curves in 3.5%NaCl solution revealed that specimens with higher DOS had lower pitting resistance. In agreement, the Rp values measured in the electrochemical impedance spectroscopy tests were higher in specimens with lower DOS.

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