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Evaluation of the Ohmic model for the quantitative determination of deleterious phases in UNS S31803 duplex steel.

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Noble steels are known to be metal alloys that are highly resistant to corrosion, due to the properties of chromium and molybdenum. However, its strength can be compromised by the emergence of intermetallic phases under adverse thermal conditions. The linear sweep voltammetry (LSV) technique is a non-destructive testing method used in the detection of deleterious phases in stainless steels, based on the analysis of the electrochemical properties of the oxide film formation mechanism on the metal microstructure. In order to evaluate the effect of the ohmic model on the formation of these oxide films and its influence on the sensitivity of intermetallic phase's detection by the technique, three samples of duplex stainless steel, UNS S31803, were prepared, which were previously solubilized at 1100 °C, and then two were subjected to isothermal aging at 870 °C for different periods of time. resulting in sigma phase (?) concentrations ranging from 0% to 2.4%. The samples were analyzed via LSV, using an electrolyte solution of potassium hydroxide at a concentration of 4 molL-1, applying sweep velocities between 1 mVs-1 and 15 mVs-1. Measurements with a Palmsens 2 electrochemical interface equipment, coupled to an electrochemical cell of Luggin capillary type, reference electrode of saturated calomel and platinum as counter electrode. The effect of oxide film formation by the ohmic model was evaluated by the response of the system to the variation of current density, charge density and ionic resistivity parameters in the voltammetric peak condition. Thus, the response relation between the peak current (Ip) and the square root of the different scan velocities (v1/2) was evaluated, based on the premise of a possible porous structure of the passive film, related to low values of the diffusion coefficients without the need to consider concentration gradients within a solid and continuous film. The response of the peak condition established a constant trend of the ionic resistivity parameter, characterized by the specific volume of the oxide film per unit charge. The evaluation of this parameter suggests that the integration of the voltammetric curve to the peak involves oxidation processes related to deleterious phases with elevated concentration of chromium. The results obtained in the assay suggest that, for high scan speeds, the quantification of the deleterious sigma phase would be more accurate under the condition of a film of uniform thickness. Thus, the experimental results suggest that the ohmic model, associated with the LSV technique, can positively influence the interpretation and use of this technique as a tool in the quantitative determination of deleterious phases in DSS alloys.