Effect of the coenzyme nicotinamide adenine dinucleotide (NAD) on the nickel free P558 stainless steel

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Abstract

Nickel, a component of stainless steels (SS) applied in orthopedic implants may cause allergic processes in human tissues. SERS spectra show that NAD adsorbs on the P558 SS in Hank´s solution. The use of spectroscopic techniques to study biological questions is a research area that has experienced significant development recent times.

Introdução

The nicotinamide adenine dinucleotide (NAD) is a coenzyme able to undergo redox action, present in several important reactions in metabolism and its biochemical role involves switching between their oxidation states.[1] The investigation of coenzyme adsorbed on metal surfaces is extremely important in a variety of fields such as biology. Classical adsorption studies are based only on the electrochemical data and provide little molecular information. Spectroscopy of the metal/solution interface provides direct molecular information. Although surface-enhanced Raman spectroscopy (SERS) is an “in situ” method of studying molecules adsorbed on the metal surface. In the present work, SERS and electrochemical studies have been employed to clarify the absorbed effect of NAD on P558 nickel free SS in Hank´s solution at 36.5±0.5 ^{o}C and pH = 7.3. SERS measurements were carried out in order to characterize the NADs adsorbed on the electrode surface and their effect on the metal/solution interface. The chemical composition of the P558 SS:16.50Cr-3.30Mo-0.48N-9.90Mn-0.40Si-0.18C.

Resultados e Discussão

The potentiodynamic polarization curves obtained from stationary potential (- 120 mV/Ag/AgCl for P558 in Hank´s solutions and -109 mV/Ag/AgCl for P558 in Hank´s solution + 10^{-4} mol dm^{-3} NAD. The passivation current densities (j_{pass}) at 100mV vs. Ag/AgCl taken from the polarization curve data are respectively equal to 8 μA/cm^2 and 0.05 μA/cm^2. It can be seen that nickel free P558 in presence NAD present lower passivating current densities than absence NAD, suggesting a more protected surface in the passivation region at 100mV vs. Ag/AgCl. This results is it agree with the literature in absence at NAD.[3] Polarization curves have shown that NAD exerts effect as an inhibitor on P558 nickel free SS.

In the solid NAD spectrum (Fig. 1 (a)) the strongest Raman signal as observed. Xiao et al.[2] have obtained the SER spectra of NAD. The have observed the nicotiamide adenine dinucleotide (NAD) at 732 cm^{-1}, 1030 cm^{-1}, 1335 cm^{-1} and 1471 cm^{-1}. On the other hand, the main features at 732 cm^{-1}, 1030 cm^{-1} are the strong signal at 1030 cm $^{-1}$ assigned to nicotinamida[3]. The comparison of the NAD solid state spectrum with that of the P558 SS / NAD + Au-NPs interface clearly shows that NAD is adsorbed on the P558 SS since the majority of the Raman features for solid NAD are closely related to those observed on the P558 surface.

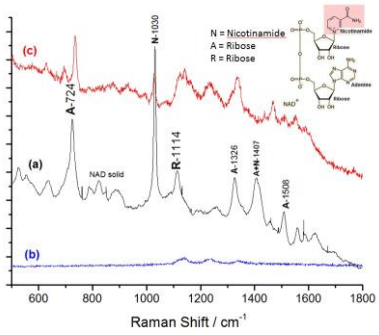

Fig 1. Raman spectra: (a) NAD solid; (b) SERS spectrum of 10^{-4} mol dm^{-3} NAD on P558 SS and (c) SERS spectrum of 10^{-4} mol dm^{-3} NAD on P558 SS with 10μL gold nanoparticle (Au-NPs).

Conclusões

Polarization curves have shown that NAD exerts effect as an inhibitor on P558 nickel free SS.
SERS spectra show that NAD adsorbs on the P558 SS in Hank´s solution.

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