Tribocorrosion under extreme conditions: radiolysis effects at the steel-316L/aqueous solution interface

N. Bérerd[1,2], N. Moncoffre[1], P. Martinet[1], S. Marcelin[3], D. Baux[4], B. Normand[3]

[1] *Université de Lyon, IP2I UMR 5822 CNRS Villeurbanne, France*
[2] *Université de Lyon, IUT Lyon 1-département de chimie, Villeurbanne, France*
[3] *Université de Lyon, INSA Lyon, MATEIS UMR 5510 CNRS, Villeurbanne, France*
[4] *Université d'Orléans, CEMHTI UPR 3079 CNRS – Orléans, France*

This work aims to study the passivation of 316L steel when in contact with radiolytic species induced by water radiolysis and to evaluate the role of the steel/irradiated solution interface in the corrosion processes. For this purpose, the steel/Na_2SO_4, 0,2 M solution interface was irradiated with proton beams in a wide range of energies between 2 and 16 MeV, varying the maximum of the energy deposition between 0.5 µm and 122 µm from the interface respectively.

The irradiation experiments were performed at the CEMHTI cyclotron in Orléans and the 4 MV Van de Graaff accelerator of the IP2I in Lyon. A dedicated irradiation device [1] implemented with an electrochemical setup allows to measure the surface reactivity of stainless steel and to characterize the resistivity distribution along the passive film thickness as a function of the irradiation conditions.

The evolution of the corrosion potential of 316L steel immersed in the aqueous electrolyte under proton irradiation is usually attributed to the modification of the oxidizing potential of the electrolyte induced by water radiolysis [2-4]. Our results show that whatever the beam energy, the corrosion potential remains unchanged. It indicates that it is the very short-lived, highly reactive radiolytic species that drive the corrosion potential and not only the recombination products such as H_2O_2. During irradiation, the evolution of the resistivity profiles in the passive film thickness, obtained from electrochemical impedance spectroscopy measurements [5-6], shows that Cr_2O_3-inner layer of the passive film becomes thinner, leading to a decrease of the corrosion resistance of the 316L stainless steel. This evolution could be attributed to radiolysis of bound water molecules in the passive film.

References

[1] Normand et al., *Corrosion Science*, **2020**, *176*, 108945.
[2] R.S. Glass et al., *Corrosion Science*, **1986**, *26(8),* 577.
[3] M. Wang et al., *Journal of Electroanalytical Chemistry*, **2015,** *737*, 141.
[4] S.S Raiman et al., *Journal of Nuclear Materials*, **2017**, *493*, 40.
[5] B. Hirschorn et al., *Journal of the Electrochemical Society*, **2010**, *157(12),* C452.
[6] S. Marcelin et al., *Journal of the Electrochemical Society*, **2021**, *168(2),* 021503.