Evaluation of electronic property and Volta potential distribution of CoCrMo alloy in presence of protein molecule by SKPFM and electrochemical

Evaluation of electronic properties and Volta potential distribution of CoCrMo alloy in presence of albumin protein molecule by SKPFM and electrochemical measurements

Ehsan Rahimi, Ruben Offoiach, Maria Lekka, Lorenzo Fedrizzi

University of Udine, Polytechnic Department of Engineering and Architecture, Udine, Italy

1.Aim and scope

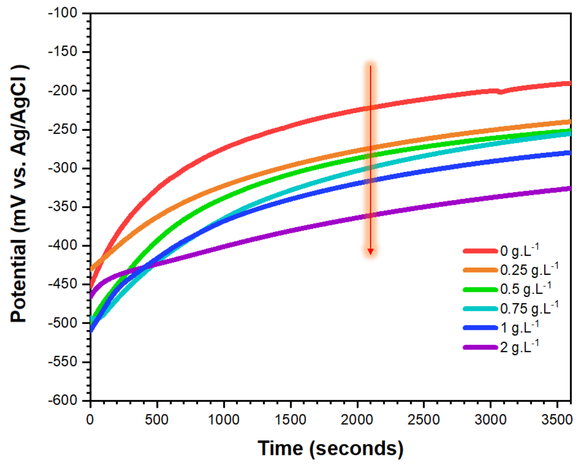
Scanning Kelvin probe force microscopy (SKPFM) has an outstanding ability to map the Volta potential (which can be directly correlated with the work function energy) on a surface with adsorbed organic molecules [1,2]. In fact, the determination of the surface Volta potential distribution on a heterogeneous surface, affected by the adsorption of different ions or organic molecules, allows to predict and determine the surface conductivity which has a direct correlation with the electrochemical activity [3]. In this research, we are trying to evaluate the effect of bovine serum Albumin (BSA) on the semiconductor character of the passive film formed on CoCrMo alloy with low carbon (ASTM F1537, 0.05 %wt C) in phosphate buffered saline (PBS) solution at different constant potentials (vs. Ag/AgCl). To this aim, different techniques such as electrochemical measurements, especially Mott-Schottky (MS) analysis, scanning electron microscopy (SEM), atomic force microscopy (AFM) and SKPFM were used.

2. Results

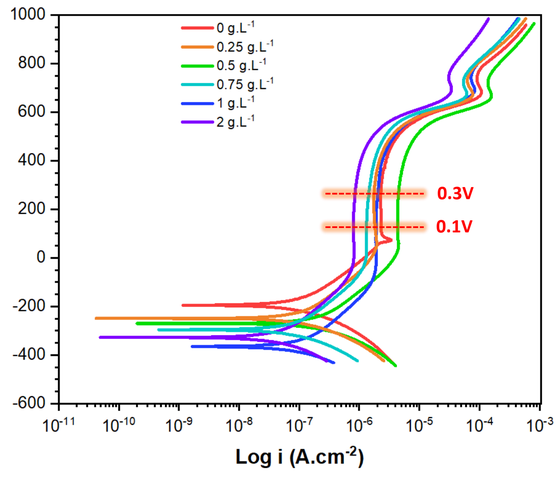
2.1. Electrochemical measurements

CoCrMo exposed to PBS plus BSA protein with various concentrations 0 to 2 g.L^{-1} for 1 hour at 37C°, pH 7.3, and aerated conditions

Open circuit potential

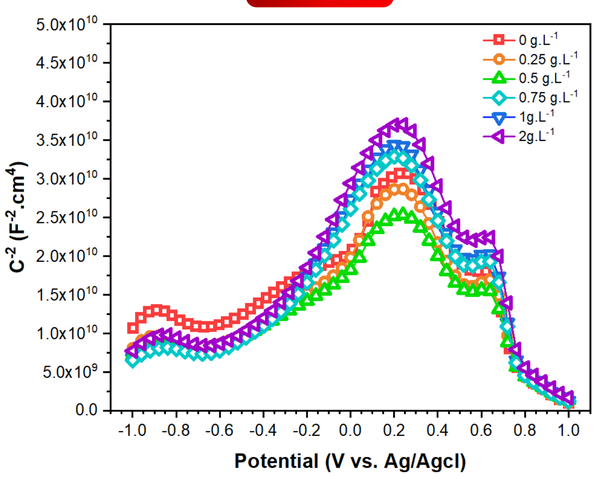


Potentiodynamic polarization

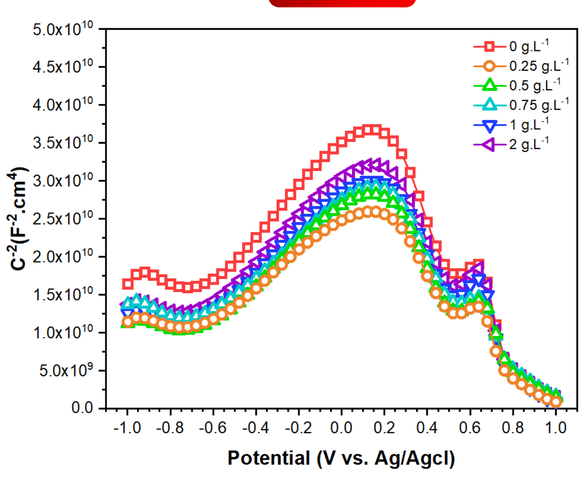


Mott-Schottky analysis

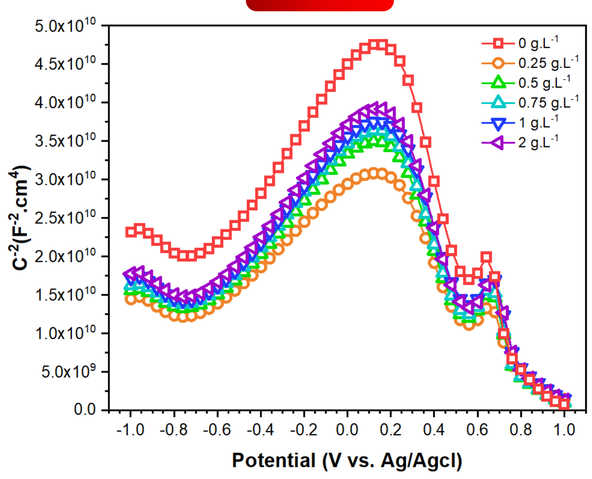
OCP



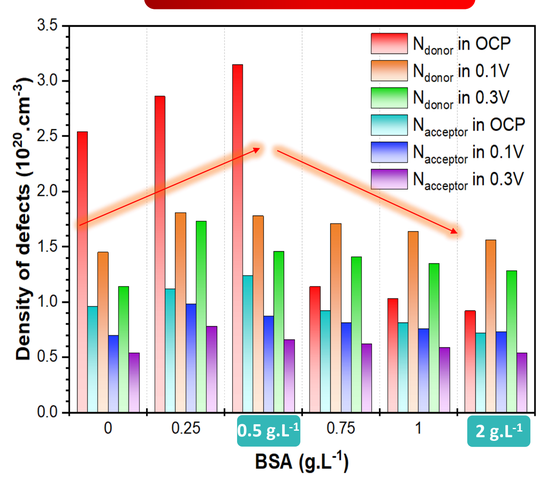
0.1V



0.3V

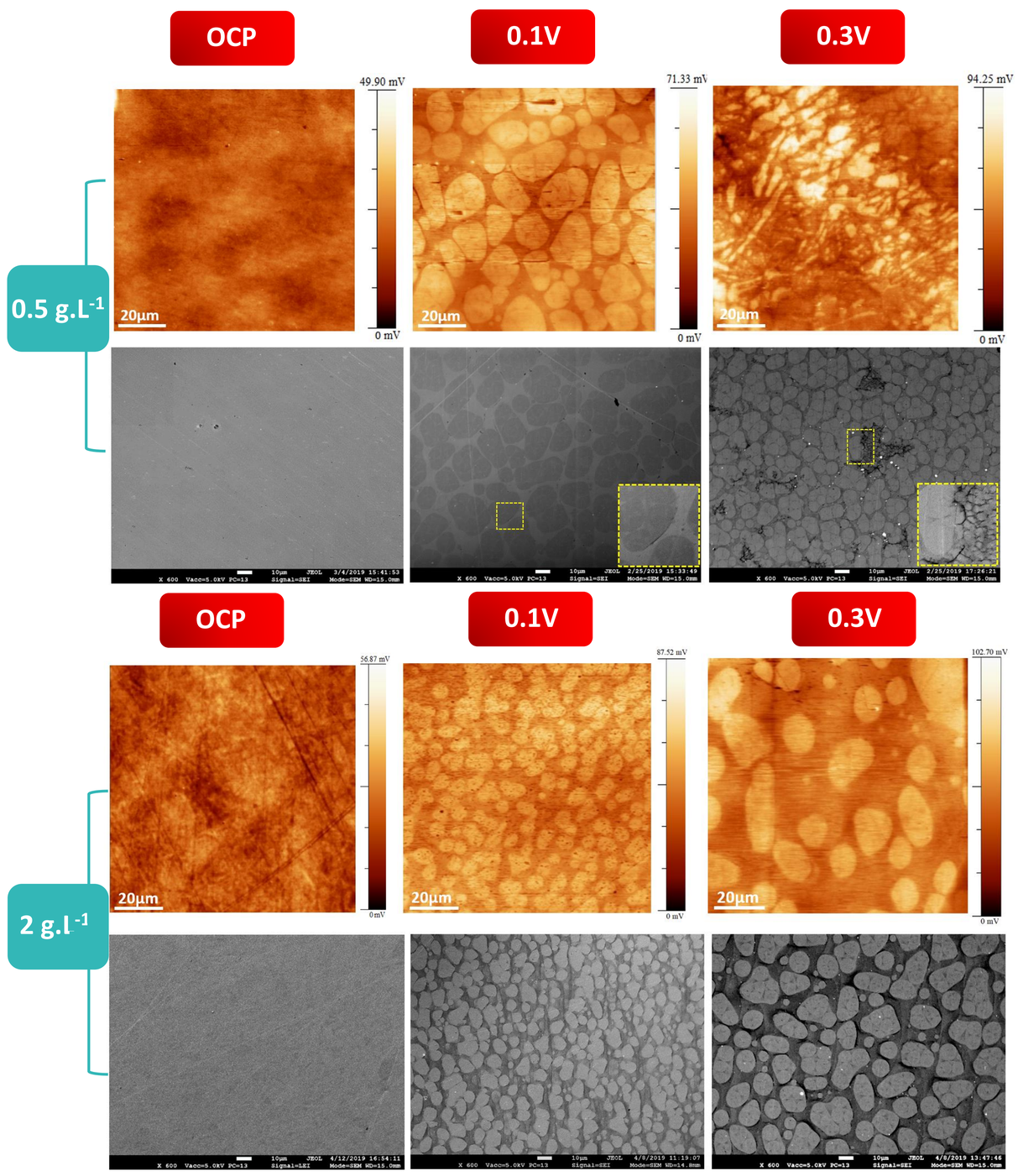


Density of defects



2.2. SKPFM and SEM analysis

CoCrMo alloy exposed to PBS plus BSA protein for 1 hour in different constant potentials at 37C°, pH 7.3, and aerated conditions



4.Conclusion

1. Adsorbed BSA forms a net on the passive oxide surface formed during polarization.
2. The regions with absorbed protein have lower surface Volta potential than the substrate (passive film).
3. Increasing the protein concentration above 0.5g/L leads to higher surface coverage and lower defects density on the passive film.
4. The protein/passive film interface is susceptible to localized corrosion initiation (pitting or crevice corrosion).

Acknowledgments:

This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Sklodowska-Curie grant agreement No 764977, mCBEEs.

References:

[1] V.Palermo, et al. ,*Chemistry communication*, (2007), 3326–3337,doi:10.1039/b701015j .
[2] C.Leung, et al, *Nano letter*, 9,2009, 2769-2773, doi:10.1021/nl9012979.
[3] M.Rohwerder, et al, *Electrochimica Acta,* 53, (2007): 290-299,doi:10.1016/j.electacta.2007.03.016.