OPTIMIZATION OF ALKANETHIOLS SELF-ASSEMBLED MONOLAYERS ON COPPER TO PREVENT ITS DISSOLUTION IN VARIOUS ENVIRONNEMENTS

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Copper is a well-known material for its widespread use in electronics, heat conductors, and canalization. Unfortunately, this metal is an active material, which undergo oxidation quite easily in humid or aqueous environment. This oxidation process is accompanied by an inconvenient dissolution of copper; problematic above all when copper pipelines are used for water distribution systems.

A suitable solution to reduce copper corrosion, as well as its dissolution, is the protection of this metal by the formation of Self-Assembled Monolayers (SAMs) of alkanethiols. Copper electrodes protected by that means have already been studied by numerous groups of researchers [1, 2, 3, 4] but, to that day, the solutions of modification as well as solutions in which copper (before and after protection) may be dissolved in during the corrosion process have never been analyzed.

The first purpose of the present study was then to determine the copper content of various alkanethiols modification cells after immersions of copper electrodes. These analyses gave useful information on the formation of links between the thiol functions and the metallic substrate and lead to the establishment of a grafting mechanism of alkanethiols on copper. The technique used for this study is the flame Atomic Absorption Spectroscopy (AAS). In a second time, the resistance of modified copper samples against corrosion, the efficiency of the SAMs, has been attested in three different media: ultra pure water, distribution water and NaCl 0.5 M. To do so, modified surfaces allowed to stay diverse periods in those three media have been studied by electrochemical methods like cyclic voltammetry and polarisation curves. Accordingly, analysis of the solutions by AAS gave information on the ability of the modification treatments to prevent dissolution of copper.

During this work, different alkanethiol molecules with various chain length and terminal functionality have been used. The choice of a suitable alkanethiol molecule and the optimization of SAMs' formation were crucial steps in our search for copper dissolution prevention. Various parameters like pre-treatment, electrochemical activation, solvent choice, concentration of the modification cell or immersion time of the samples have been taken into account. All surfaces were characterized by X-Ray Photoelectron Spectroscopy (XPS).

References

[1] G.K. Jennings, P.E. Laibinis, Colloids and Surfaces A, 116, 1996, 1405-114

[2] R. Haneda, H. Nishihara, K. Aramaki, J. Electrochem. Soc., 144 (4), 1997, 1215-1221

[3] F.P. Zamborini, J.K. Campbell, R.M. Crooks, Langmuir, 14, 1998, 640-647

[4] R. Tremont, H. De Jesus-Cardona, J. Garcia-Orozco, R.J. Castro, C.R. Cabrera, Journal of Applied Electrochem., 30 (6), 2000, 737-743

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