Electrochemical and surface studies of the effect of naphthalene-based additives on tin electrodeposition

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Propositions

accompanying the thesis

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1. Tin electrodeposition on gold involves three well-known deposition mechanisms: irreversible adsorption, underpotential deposition, and overpotential (bulk) deposition. However, the underpotential tin deposition on gold is however somewhat uncharacteristic as it is associated with island formation and surface alloying.

   Chapter 2 of this thesis; B. W. Mao, J. Tang, and R. Randler, Langmuir, 18, 5329–5332 (2002)

2. The nature of the anions from the supporting electrolyte plays an important role on the tin electrodeposition process. Methanesulfonate anions slow down the tin bulk deposition process on gold in comparison to sulfate anions.

   Chapter 2 of this thesis

3. Surface studies showed that naphthalene-based additives (NPT, NPTS, HNPTS) form films on a gold electrode, where NPT and NPTS lie flat on the surface and NPTS forms a denser film due to intermolecular attractive interactions. Furthermore, HNPTS undergoes polymerization processes. Neither phenomenon is very sensitive to the electrode material.

   Chapter 3 of this thesis

4. α-Ethoxylated napthalenesulfonic acid (ENSA-6), a commonly used additive on tin electroplating industry, has a strong effect on the tin bulk deposition process, but no or little effect on the early stages of the tin deposition process on gold, i.e., during the formation of AuSn (surface) alloys.

   Chapter 3 of this thesis

5. Industrial research might not be frequently interested in the use of well-defined surfaces (single crystals) to study electrodeposition processes. Nonetheless, this work has proved that the use of well-defined surfaces allows us to extract fundamental knowledge to be used on more complex systems.

6. ENSA-6 exhibits a very strong inhibition of tin deposition on iron, gold and BDD correlated with the reduction in the transport of tin (II) ions to the electrode surface. A decrease in the

mass transport of Sn (II) ions as a consequence of the ENSA film on the electrode surface is likely.

Chapters 3, 4 and 5 of this thesis

7. In-situ spectro-electrochemical studies are required to understand the interaction of single molecules and mixtures of molecules, used as additives, with the substrate. These studies will allow to comprehend the role of additives during the nucleation and growth of tin deposits.

   Chapter 3 of this thesis

8. Despite the large number of studies that acknowledge the importance of species in the bulk solution in the tin electroplating processes, there are virtually no studies that investigate the speciation of the tin electroplating solutions, impeding the improvement of tin and other electroplating processes.

9. The industrial development depends on the rate of the acquisition and the effective use of new knowledge. A solid external network of the companies with the universities and research institutes will facilitate the identification of specific problems and the finding of optimal solutions.