



CYCLE DE CONFÉRENCES DE CHIMIE

*Avec le concours de : Manufacture Française des Pneumatiques MICHELIN
SIGMA Clermont
Institut de Chimie de Clermont-Ferrand (ICCF UMR 6296)
U.F.R. de Chimie*

Vendredi 6 avril à 11 h

Amphi Rémi (site des Cézeaux)

Hubert PERROT

Laboratoire Interfaces et Systèmes Electrochimiques, UMR 8235, Paris

Investigations of various capacitive/faradaic materials through multi-scale coupled methods

Capacitive or faradaic materials are often used as thin films coating the metallic electrode in various applications like energy storage, energy conversion, biosensors domains. Charge transport, charge transfer reactions or electro-adsorption phenomena must play key roles in the electrochemical response of these electroactive films. It is commonly admitted that the oxidation process or anodic potential applied to such a film requires either a cation expulsion or an anion entry to compensate for the positive charges formed inside the film. However, it has been shown that these processes in electroactive films are accompanied, not only by the exchange of ions with the electrolyte solution but also by solvent exchanges. As electroneutrality is required, it is generally assumed that the field-assisted transport of charged species is more rapid than the transport of neutral species and, consequently, solvation equilibria can be only slowly established. Therefore, the equilibria associated with electronic, ionic, and solvation processes may be established on quite different time scales, but, at long enough time scales, thermodynamics will prevail and processes will attain a state of global equilibrium. However, the relative rates of all the processes involved in the charge compensation are still an open question for capacitive and faradaic materials.

Different techniques can be used to investigate ionic and solvent transfer and transport in electroactive materials. As the models employed are largely dependent on the techniques used to test them, different approaches can be used. The electrochemical investigation of electroactive films, in terms of voltammetry and electrochemical impedances, takes into account the charged species involved in the electrochemical process of the film. The addition of gravimetric investigations thanks to quartz crystal microbalances allows the solvent interaction to be attained. In order to discriminate the contribution of each involved species, charged or not, a multi scale coupling method of characterization was developed by coupling a fast quartz crystal microbalance to electrochemical impedances measurements. More precisely, *ac*-electrogravimetry allows the mass response to a small potential perturbation to be analyzed thanks to this fast quartz crystal microbalance used in dynamic regime. Thus, *ac*-electrogravimetry was employed to characterize ions and solvent motion at the film/electrolyte interface during the electrochemical reactions of electroactive material. This technique was already fruitful in several domains: ionic and solvent insertion in inorganic films (Prussian Blue), conducting polymer layers (polypyrrole, polyaniline, POT, PEDOT), taking account the film porosity, in PEMFC (hybride films, composite nafion layers) and more recently in films based on carbon material (carbone nanotubes, reduced graphene oxide).

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