BENEMÉRITA UNIVERSIDAD AUTÓNOMA DE PUEBLA

INSTITUTO DE FÍSICA
"Luis Rivera Terrazas"

SEMINARIO EXTRAORDINARIO
"DR. JESUS REYES CORONA"

"Role of spectroscopic techniques in characterization of electrode/electrolyte interface reactions in Li-ion batteries"

Dra. Jolanta Światowska
Institut de Recherche de Chimie Paris (IRCP)

Understanding the electrode processes occurring at the electrode/electrolyte interfaces and in the bulk electrode materials is necessary for development of high energy density batteries (lithium-ion, sodium-ion or sulfur batteries) for portable and transport applications. The main electrode processes in Li-ion batteries (LIB) are insertion/extraction reactions that induce chemical and morphological changes in the positive and negative electrode materials. These reactions are accompanied by decomposition of electrolyte that leads to formation of passive layer. The passive layer formed on the negative electrode material, widely known as a solid electrolyte interphase (SEI) layer [1], strongly influences the battery performance and cycle life of battery. Much thinner passive layer named as a solid permeable interphase (SPI) layer [1], can be formed on the positive electrode material. The mechanism of electrode passivation is even more complicated if the electrode material is not stable during the process of lithiation/delithiation and cycling and undergoes the volume changes expansion/shrinkage. The strong electrode modifications occur in the case of high capacity alloying or conversion-type electrode materials, such as Si-based or transition metal oxide/sulfide-base materials, respectively [2, 3]. To have a better insight into these different reactions induced by electrochemical processes the advanced surface-sensitive techniques: X–ray photoelectron spectroscopy (XPS) and time-of-flight secondary ion mass spectrometry (ToF-SIMS) are particularly suitable for characterization of chemical modifications of electrode materials. Apart the chemical composition of the surface SEI layer, a dynamic increase/decrease of SEI upon lithiation/delithiation, and the irreversible chemical and volume modifications of electrode materials upon cycling evidenced by ToF-SIMS ion depth profiles will be discussed. Using ToF-SIMS ion depth concentration profiles the ionic transport properties of different electrode materials can be estimated [4]. The ionic transport of Li can be limited by Li trapping in the bulk of electrode material, at the interfaces, formation and growth of the SEI layer.

Referencias

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