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Electronic Spectroscopy at the Solid-Liquid Interface: A Window to Electrochemistry and Solvation Phenomena

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Basic phenomena in electrochemistry, and environmental science occur at solid-liquid interfaces. To obtain information on the atomic structure, composition, electronic levels of surface and adsorbed molecules optical (IR, SFG), structural (STM, AFM, GIXS), and x-ray spectroscopy techniques (XAS-XES) can be used. In fluorescence yield mode, XAS provides information on the electronic structure of sample materials within the escape/penetration depth of x-rays, which for soft x-rays is about 100-1000 nm. In my laboratory we use a well-known variant known as electron yield mode (EY-XAS), by measuring the electrode current which is the balance between emission and capture of secondary electrons. We applied EY-XAS to study electrode interfaces in aqueous electrolytes. In the case of graphene we studied reactions leading to the oxidation. In the case of gold we determined the orientation of water molecules near the interface, due to interaction with gold and as a function of applied bias. In the case of Platinum we studied oxidation-reduction reactions in acid electrolytes. Because XAS spectra are dependent on x-ray absorption rules and transition probabilities in the presence of core holes, interpretation of the spectra is not trivial and requires theoretical calculations for a meaningful interpretation.