**Surface Functionality Of Graphene-family Nanomaterials On Electronic And Phononic Properties For Applied Electrochemistry**

**Abstract**

We present optical and lattice vibrational properties of a range of functionalized graphene-family nanomaterials using UV-visible absorption, photoluminescence excitation (PLE) and micro-Raman spectroscopy techniques. Various functionalized graphene nanomaterials include few layer graphene oxide, reduced graphene oxide, graphene quantum dots and three-dimensional scaffolds graphene aerogel and their nitrogenated functionalized counterparts. Raman spectroscopy (RS) provides lattice dynamical structural characterization at nanoscale revealing collective atomic/molecular motions and localized vibrations. The role of oxygen epoxy (C-O-C, carbonyl, C=O) and nitrogen (pryridinic and graphitic/pyrrolic) functionalities and corresponding bonding configurations with quantum size effects are emphasized in view of understanding physico-chemical properties for biosensing and water desalination. While first- and second-order phonon modes are analyzed in terms of Raman intensity, band position (intrinsic mechanical strain) and intensity ratio (structural disorder, number defect density), distinct localized π electronic states were found in PLE spectra at the carbon atoms around oxygenated and nitrogenated species. The origin of these states is discussed based on experimental findings and density functional theory exemplifying structural evolution.