Materials Science & Engineering / Metallurgy Grad Seminar

Wednesday, October 3 2018, 4:10-5:00PM, WEB 1230

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Using Microcalorimetry and Reactions Energetics to Probe the Surface of Metal Oxides Nanomaterials

Great emphasis has been focused on understanding reactions at nanomaterials surfaces and interfaces, above all metal oxides nanomaterials (MON)/solutions systems. These interfacial chemical reactions – protonation, exchange, adsorption, desorption, redox, etc. are at the heart of many fundamental scientific questions in geological, environmental, planetary and even technological applications, and have significant repercussions in many fields. A host of experimental and computational techniques have been applied to these studies over the last 20 years. Yet among the hundreds of studies published in relation to MON/solution interfaces, very few deal with the thermodynamics of interfacial reactions and even fewer have been directly supported by experimental data. The purpose of this presentation is to introduce a way to change this paradigm through the construction and applications of innovative flow microcalorimetry (FMC) instrumentations and techniques developed in my laboratory to directly measure the energetics of these interfacial reactions on several MON surfaces.
Besides providing information of thermodynamic significance, i.e., heats of reactions (Q in mJ/mg) and enthalpy changes (ΔH in kJ/mol^{-1}), FMC can also provide information about changes that occur in the properties of a surface in situ with varying experimental conditions and high temporal resolution. Illustrative examples will be provided to showcase the usefulness of calorimetrically collected data in general surface studies as well as in theoretical modeling frameworks correlating MON structure, charge distribution and reactivity. Integrating key thermodynamic data with the advances and sophistication other theoretical, experimental and computational methods have achieved maps out the blueprints of the next-generation of surface reactivity research.

Dr. Kabengi is an associate professor in the Department of Geosciences at Georgia State University with a joint appointment with the Chemistry Department. Dr. Kabengi's research explores fundamental surface chemical reactions occurring at interfaces between surfaces and aqueous solutions and the role these interfacial reactions play in geochemical, environmental, and technological contexts. Dr. Kabengi expertise lies in the application and construction of flow microcalorimeters techniques and instrumentations for measuring the energetics and thermodynamic properties of various chemical surface reactions.