Solid-state Nuclear Magnetic Resonance of Next Generation Materials

PROJECT DESCRIPTION

"With their incredible potential to be chemically tuned for specific functions, materials encompass an amazing range of chemical systems from bioactive catalysts and structural matrices to photovoltaics. Despite this success, the “trial & error approach” employed for hard and soft materials has stifled advancements. Demand for further improvements in biomaterials is prompted by an aging global population and by the fact that the majority of people will require treatment for dental caries. The formation of Apatite, A5 (XO4)3Z, is one important process for biocompatibility. Apatite is a class of phosphate minerals that can accept varied ion substitutions at the A, X and Z positions. Scientific researchers have used the A and X positions to produce various functions within apatite including ionic conduction and long-term nuclear waste storage. Earth scientists have utilized Z substitutions for petrology indicators within igneous and metamorphic rocks, including lunar research. Z-site substitutions (Z = OH, F or Cl) of hydroxyapatite (HA, Ca5 (PO4)3OHX) is essential for calcification within living hard tissues including human dentin and bone, and hyper-mineralization within crustaceans. Our current research program is directed at inorganic biomaterials of ordered (apatite based) and disordered (bioglass-ceramics) materials to characterize and improve oxide-containing biomaterials used for replacement or regeneration within the dental and medical applications.

We are also interested in perovskite-based optoelectronic and photovoltaic materials and catalytic microporous systems. For example, the unprecedented rise in the efficiency of organic-inorganic lead halide perovskite solar cells has captured the attention of the scientific community, with rapid advancement in efficiency over the past five years. The ease in which perovskite based solar cells can be manufactured at low temperatures and using a solution-based approach makes them extremely attractive when compared to convention solar cells. The most effective perovskite is the methyl ammonium (MA) lead iodide (MAPbI3) which has been shown to deliver an efficient ~20% conversion, unfortunately the stability of such a species in the natural environment is of concern for the conventional lifetime solar cells are in use (i.e., 20 to 30 years). This is due to its propensity to breakdown under routine conditions including the high temperature phase change which occurs at (>60 oC,) and its hydroscopic nature, namely absorbing water eventually forming PbI2, a highly water solution lead salt. This has lead to great concerns regarding the leaching of Pb based salts into the environment, leading to severe socioeconomic issues if not contained. SSNMR is the single most important structural tool we have at our disposal to identify and quantify atomic-level structure in these ordered and disordered solids. Research candidates should have an urge to use chemistry and materials to improve the well-being for all humanity through environmental and social health applications. Interest and skills with high temperature oxide chemistry, biomaterials, glass-ceramics, physical/materials chemistry and/or a background in SSNMR would be valuable assets for this program. Students who are interested should have some physical chemistry, physics, geochemistry or engineering background as spectroscopy is used extensively within our research group. “

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FACULTY-DEPARTMENT

Science- Chemistry

DESIRED FIELD OF (STUDENT) STUDY

Chemistry, Physics or Engineering background

INTERNSHIP LOCATION

University of Alberta Main Campus - Edmonton

NUMBER OF INTERNSHIP POSITIONS

2

INTERNSHIP START DATE

July 4, 2018

INTERNSHIP END DATE

3 months after start date

ARE THE DATES FLEXIBLE?

Yes, I am flexible regarding the internship dates. Selected students can contact me to request a date change.

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