



Department of Chemistry Seminar Series Fall 2023

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Building a Toolbox for Sustainable Synthesis and Catalysis



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Our multidisciplinary research group focuses on molecular inorganic synthesis, thin film materials via atomic layer deposition (ALD), and heterogeneous catalysis for fine chemical transformations. Our long term goal is the convergence of these subdisciplines of inorganic chemistry towards the synthesis of complex hierarchical catalyst systems that are active, selective, and highly reusable. In parallel, we adhere to sustainability concepts and the 12 Principles of Green Chemistry as we engage in these pursuits. Specifically, we are seeking to discover and develop sustainable synthetic methodologies enroute to our desired end products – often these alternative routes enable the synthesis of previously inaccessible, or difficult to access products.

To that end, the presentation will focus on three of our current areas of interest:

1. Mechanochemical synthesis: by leveraging mechanochemical forces via vibratory ball milling or ultrasonic irradiation, we can expedite the synthesis of both conventional, and exotic Schiff base coordination complexes. Critically these reactions can be performed solvent-free or solvent-minimal, and facilitate the formation of target compounds in one-pot and one-step from multiple starting materials in minutes-to-hours compared to conventional multi-day, multi-step processes.

2. Silane-based reductions: using stoichiometric silanes, high-valent, mid d-block metal halides can be controllably, stoichiometrically reduced to highly reactive mid-valent synthons (e.g. MoCl_3 from MoCl_5). The reactions are facile, and produce only H_2 and recoverable and reusable chlorosilanes as byproduct. The resulting mid-valent metal chlorides form ideal starting points towards new precursors for ALD and chemical vapor deposition (CVD); enabling technologies for coatings, electronic materials, and heterogeneous catalysis.

3. Monolith-based nanocatalysts: controlled growth of nanocatalysts on contiguous Ni foams. Ni foams afford numerous advantages; among these include ease of handling and facile separability inherent to monolith systems, a porous 3-D membrane framework amenable to application in continuous flow catalysis, the potential for resistive heating, and ferromagnetism which enables self-stirring. The application of these materials towards the catalytic hydrogenation of nitro, alkene, and alkyne moieties, in batch and flow, under mild conditions will be discussed.