Additive manufacturing (AM), also called three-dimensional (3D) printing, holds significant potential for manufacturing novel designs and materials for energy conversion and storage devices, which were previously unattainable due to the constraints of traditional manufacturing methods. However, AM suffers from certain limitations that hinder the use of AM in the field of energy research, including: 1) lack of energy materials available for AM; 2) multi-material AM; and 3) feature size and accuracy. In order to overcome these limitations, we have developed a universal multi-material 3D printer that is capable of printing metals, thermoplastics, gels, pastes, elastomers, and nanocomposites. By using this universal multi-material 3D printer, we have been able to 3D print copper, steel, aluminum, silver, nickel, cobalt, ionic gels, carbon fiber-based nanocomposites, titanium dioxide, various thermoplastics, wood, and epoxies. With the success of this universal material 3D printer, we began to focus on developing 3D printed vanadium redox flow batteries by using recycled vanadium collected from ammonia slag. Ammonia slag, which is a by-product of the Haber-Bosch process (the main industrial procedure for ammonia production), is an industrial waste that is not recycled and typically contains up to 5-10% vanadium oxide.

All components of the VRFB, except the ion exchange membrane, are fabricated by the universal multi-material 3D printer (see Figure 1). This 3D printer allows rapid testing of different design components in order to study optimum cell design, print different parts of the cell body, develop conductive printable materials for microstructured electrodes, which are important to maximize the mass transport for the redox medium. The fabricated 3D printed carbon fiber-polydimethylsiloxane (PDMS) composite, with integrated microflow channels, shows great potential for use as the VRFB electrode material. We are combining functions in VRFBs that are not limited to just power delivery; in fact, VRFBs can be integrated with energy harvesting devices, such as photovoltaic cells and wind energy devices (such as wind turbines) in order to re-charge the VRFBs.

Coffee & Timbits will be served at 11:00 a.m.  
(room is busy until 11:00)