This research highlights one aspect of the program run by Professor Byron Gates of the Department of Chemistry and Associate Member, School of Mechatronic Systems Engineering, and Co-Founder of 4D LABS at SFU. He runs an interdisciplinary research program in advanced materials that supports team members across multiple stages of their career (undergraduate to graduate to post-doctoral to senior scientist to visiting scientist). He works with collaborators from around the world (e.g., Canada,

Dr. Gurbinder Kaur, Senior Research Scientist in Chemistry at SFU with training in Physics and Materials Science, is developing coating materials for the cathodes of lithium-ion batteries (LIBs)

Ms. Kelsey Duncan, Graduate Chemistry Student, is enhancing the durability of electrochemical materials, including cathode materials for LIBs, and improving our ability to study the aging and failure mechanisms of these materials.

Ms. Katherine Manarin, Undergraduate Student majoring in Chemistry and Physics is developing and testing new coating materials for stabilizing cathodes of LIBs.

Dr. Xin Zhang, Materials and Device Testing Manager of 4D LABS at SFU who is also in charge of the Electron Microscopy facilities in 4D LABS, ensuring proper up-keep of these tools, basic through advanced training of students, and assistance with sample analyses. (www.4dlabs.ca)

Dr. Lis Melo, Specialist, Materials Characterization of 4D LABS at SFU, who oversees TEM techniques, amongst other techniques in 4D LABS, to ensure that users have access to a wide range of advanced techniques to characterize their materials. (www.4dlabs.ca)

Other members of our team and other research projects that we are pursuing can be found here: http://www.sfu.ca/chemistry/gates/

The growing popularity of electric vehicles (EVs) and an increased need for energy storage solutions have required improvements in their lithium-ion batteries, with increased power and higher energy densities. Lithium-ion batteries (LIBs) are one of the most sought-after energy storage solutions for our current and future needs in rechargeable batteries, which is attributed in part to their relatively high energy density. LIBs are typically composed of a graphite anode (negative electrode) and a cathode (positive electrode) typically a crystalline transition metal oxide material. In anodes and cathodes, there are atomic-scale ‘holes’ in the crystals that can reversibly store or release lithium ions, this is called lithium intercalation and is the key property that makes rechargeable LIBs possible. These types of battery materials have played a large role in enabling portable electronic devices, such as cell phones, since their commercialization in 1991. Many challenges with LIBs have hindered advances to these materials for over 40 years. Key challenges include volume expansion, instability of electrolytes and additives leading to unwanted reactions that can form a insulating layer called the solid electrolyte interface (SEI), and dissolution of metal species from cathode materials. For instance, some incidents in recent years include the explosion of Samsung Note 7 phones (2016), fires in batteries on Boeing 787 planes (2013), and the combustion of Tesla Model S cars (2019). These safety issues impose serious threats to human health or life. Safety is an indispensable prerequisite for the design of batteries that address our large-scale energy storage needs. T

A complementary technique is transmission electron microscope (TEM) that projects a beam of electrons through nanoscale-thin samples that are also held under high vacuum. Also in the video, Ms. Duncan is using a TEM in 4D LABS to observe the atomic composition, crystal structure, and other properties of the coated cathode materials.

The team is working to development of new, advanced materials for rechargeable battery technologies. This research requires an interdisciplinary expertise and access to advanced equipment available at SFU. There are many opportunities available to participate in research programs across the university. Get involved! See what you can achieve to advance your own skills but to also participate in teams to create

3) what are some of the challenges of this cathode technology for reversible batteries?

(degradation of the materials within the lithium ion batteries, which can batteries (e.g., Na) that are sought for their lower cost, studying both electron and ion transport in custom materials, and developing new electrochemical testing protocols)

(training requires a range of specializations. Working as an interdisciplinary team of researchers from, for example, chemistry, physics, materials science, and engineering, affords the range of skills needed to solve the challenges before us)