**Carleton University**

Department of Mechanical and Aerospace Engineering

Graduate Seminar Series

Friday November 13th, 2020, 1:00 - 2:00 PM EDT (Ottawa Time)

## Synergistic Effects of Halloysite Nanotubes on the Tensile Dynamic Fracture Toughness of Polyurethane

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**Abstract**

##### Polyurethanes are commonly used in transparent armor systems to increase the survivability, blast resistance, multi-hit resistance and fragment containment of multi-layered systems. The high tensile-ductility, fracture toughness and self-healing ability are key factors that determine the performance of polyurethanes under high-strain rate conditions. In this talk, a polyurethane nanocomposite is presented that dramatically improves the macromolecular structure’s ability to resist fracture. The polyurethane prepolymer was partially silane end-capped and reacted with only 0.8 wt.% acid-treated Halloysite nanotubes in a relatively inexpensive and moisture-curable synthesis process. The resultant nanocomposite material presents a 35% higher spall strength compared to the neat polyurethane under similar dynamic loading conditions, and a 21% higher value of fracture toughness. Analysis of the free-surface velocity histories, combined with fractographies of the spalled surfaces obtained via scanning electron microscopy, provides information about the failure mechanism and fracture kinetics. The neat polyurethane presents a sharper front spall pulse, indicating a more instantaneous fracture, and therefore lower fracture toughness. The nanocomposite presents a more energy dissipative fracture mechanism characterized by a rougher fracture surface with extensive fibrillation.

**Bio**

Rafaela Aguiar obtained her bachelor’s degree in Materials Engineering at the Federal Center for Technological Education of Minas Gerais in Brazil. She is a PhD candidate in Mechanical Engineering at Carleton University being supervised by Professor Ron Miller and Professor Oren Petel, her current research efforts involve the development of transparent armour materials, focusing on using additives to alter the micro-behaviour of the polymeric materials under high-strain-rate loading conditions. Her previous research experience consists of working with rare earth oxides in a ceramic matrix using the sol-gel synthesis technique. Her previous work with TRIP Steel heat treatments at Federal Center for Technological Education of Minas Gerais involved analyzing the microstructural evolution mechanisms involved in the formation of bainite. Her industrial experience includes using finite element methods in the development of a conveyor pulley sizing software for FNTC.