



## **MIE498H1: Research Thesis 2024-2025**

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<b>Number of Positions</b>	1
<b>Open to</b>	Mechanical Engineering Students
<b>Term Offered</b>	Full-Year (Y)
<b>Research Area</b>	Materials
<b>Research Topic</b>	Transforming Polymer Waste into High-Value Carbon Products and Composites: A Sustainable Solution

### **Project Description**

Hierarchical fibre-inspired structures are key to creating hybrid composites with high strength and toughness. These structures mimic the design of natural materials, such as bone, seashells, and silk, which have evolved to overcome the limitations of their constituent elements and compounds. By arranging these components hierarchically, from molecular to macroscopic scales, natural materials achieve enhanced mechanical and functional properties that are not predictable by the rule of mixtures. This work aims to apply the same principle of bioinspired materials design to develop synthetic composites with superior performance and durability. Graphene nanoplatelets (GnPs) are plate-shaped nanocrystals made of stacked graphene layers held together by van der Waals forces. They have attracted much attention for their potential to improve the mechanical, thermal, and electrical properties of composites. By combining GnPs with conventional fillers like glass fibre (GF), a hierarchical structure can be formed that enhances load transfer at the fibre/matrix interface and improves the composite's mechanical behaviour. GnPs can form chemical bonds with GF sizing and create GnP-rich regions at the fibre/matrix interface. Adding a small amount of GnP can create a hierarchical structure and cause trans-crystallization and grain refinement in the fibre/matrix interface, leading to higher mechanical performance of the composite under tensile and flexural loading. The hybrid composite can also offer high electrical and thermal conductivity lightweight solutions for EMI applications. Other hybrid nanofiller work is ongoing.

<b>Additional Information</b>	N/A
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<b>Application Instructions</b>	Please submit CV, unofficial transcript, to Prof. Patrick Lee (patricklee@mie.utoronto.ca)
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