Mechanical & Industrial Engineering
UNIVERSITY OF TORONTO

MIE498H1: Research Thesis 2023-2024

Supervisor	Patrick Lee
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Number of Positions	1
Open to	Mechanical Engineering Students
Term Offered	Full-Year (Y)
Research Area	Materials
Research Topic	Lightweighting of Elastomeric Polymers for Flexible Foam Applications

Project Description

The development of high-performance flexible foams for sportswear applications has garnered significant interest in recent times. Advanced sportswear, particularly high-performance aesthetic sneakers, predominantly utilize polyurethane and ethylene-vinyl acetate for their foam components. However, despite their widespread availability and ease of processing, commodity plastics like polypropylene (PP) and polyethylene (PE) are rarely employed due to their inherent weak melt-strength. To address this drawback, an area of interest is studying the effects of incorporating physical or chemical crosslinking mechanisms into propyl-ethyl based polymers, through the addition of ionic pendant groups and chemical crosslinkers, respectively. Integration of these crosslinks in the backbone of PP chains will significantly increase their melt-strength and foaming performance. The ability for neighboring ionic pendant groups to bond, forming physical cross-linking points referred to as ion clusters, is believed to provide high resistance to extensional flow, which leads to significantly enhanced foaming performance. In contrast, chemical crosslinking involves the addition of a crosslinking agent alongside co-agents that allow for permanent bond formation; this essentially imparts thermosetting properties on traditional thermoplastics such as PP and PE. Additionally, the incorporation of PE in the PP matrix contributes to the overall elasticity of the final foam product and increases the percent recovery upon cyclic compression (i.e., typical deformation for sportswear applications). A typical batch foaming set-up will be used to foam the prepared resins using supercritical CO2. By screening resins with a widespread range of PE content and a wide range of foaming temperatures, we aim to uncover the optimal composition required.

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