# Barocaloric Properties of Graphene-Shape Memory Polymer Nanocomposites

**Naveen Weerasekera[1]**, Kavish Sudan[1], Kameswara Pavan Kumar Ajjarapu[1], Gamini Sumanasekera[2], Kunal Kate[1], and Bikram Bhatia[1]

[1]*Department of Mechanical Engineering, University of Louisville, KY*

[2]*Department of Physics and Astronomy, University of Louisville, KY*

## Abstract

Solid state refrigeration based on caloric materials has demonstrated the ability to replace existing vapor compression cooling systems that are inefficient, difficult to scale and have a high global warming potential. Unlike solid state cooling based on electrocaloric, magnetocaloric and elastocaloric effects, barocaloric refrigeration – based on the entropy change due to applied hydrostatic pressure – have received comparatively less attention but have recently demonstrated significant potential in material-level studies. Soft materials, such as elastomers and plastic crystals, exhibit significant barocaloric response at relatively low hydrostatic pressures, making them attractive candidates for solid-state refrigerants with wide operating temperature ranges. However, the low thermal conductivity of these materials poses a challenge for efficient thermal management in barocaloric cooling devices. In this study, we introduce a thermoplastic polyurethane-based shape memory polymer and evaluate its barocaloric performance while enhancing its thermal conductivity. We conducted quasi-adiabatic tests on the material and observed a direct temperature change of 14.3 K when subjected to 434 MPa applied hydrostatic pressure, indicating a total operating range of approximately 28 K. To improve its thermal conductivity, we added up to 6% graphene by weight and achieved an increase in thermal conductivity of up to 1.5X at room temperature (293 K) and 2X near its melting temperature (408 K). Even though the addition of graphene led to an 18% reduction in the quasi-adiabatic temperature change of the material, it still provided a maximum operating temperature range of 24.4 K at 434 MPa pressure and a promise of significantly higher cooling power. This graphene-enhanced nanocomposite can be a promising refrigerant for next-generation solid-state cooling.

## Biography of Presenter

Naveen Weerasekera is a PhD candidate in the Department of Mechanical Engineering at the University of Louisville. Prior to joining UofL, he obtained his MS degree in Mechanical Engineering from Portland State University in Oregon. His research primarily revolves around developing high-performance solid-state refrigerant materials and cooling devices operating on hydrostatic pressure. Currently, he serves as a research and teaching assistant at the University of Louisville.