Master's Thesis Defense Announcement
Mechanical and Aerospace Engineering Department
University of Texas at Arlington

Thermally charging capacitor: A new protocol to accurately measure thermovoltage

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10:00 AM, Monday, 12/12/2022

Wolf Hall Room no 413

Abstract

Harvesting energy from waste heat would benefit in creating sustainable systems. Specifically, thermoelectric energy conversion can be used for low-grade waste heat recovery. However, the efficiency of conventional solid-state (i.e., semiconductor) has reached to the upper limit and could not make any advancement for more than 30 years. As a paradigm shift from solid-state thermoelectric conversion, in this study, ionic thermoelectric phenomena in liquid are explored.

An electrolyte, with disproportionate size of anions and cations, when subjected to a temperature gradient can experience induced ion separation. In the phenomenon known as "Soret effect", the smaller ions with higher mobility move away from the hot surface and gather on to the cold surface. When it occurs in electrochemical cell, temperature gradient can generate electric potential (i.e., thermopotential) across the cell.

In this study, an ionic liquid, 1-ethyl-3-methylimidazolium triflate was used and its Soret effect was investigated. Note that ionic liquids are salts of small cations and huge organic anions, and they can be good candidates for effective thermopotential generation. For this investigation, a novel protocol for set-up and measurement of thermopotential in the ionic liquid was established, wherein a stable equilibrium potential is first recorded and then a thermovoltage is established, to more accurately evaluate the effect of temperature gradient on the ion separation. Further, for the first time, directionality of charging mechanism by reversing temperature gradient, is shown as evidence of the Soret effect. In addition, the charging of capacitors using the thermopotential is demonstrated. This demonstration provides the references for developing thermally charging supercapacitor in the future.