Thermoelectric coefficient dependency on chemical composition of ionic liquid based ferrofluids

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In recent years, complex fluids are attracting attention as an alternative thermoelectric (TE) material. Unlike in solids, several inter-dependent TE effects take place in such fluids; most notably, the electrochemical (thermogalvanic) reactions of redox salts, the thermodiffusion of charged species and the electronic double-layer formation of ions near the electrodes. They possess Seebeck (or temperature) coefficient values that are generally an order of magnitude larger, and are made of cheap and abundant raw materials compared to the semiconductor counterparts, their TE power-output remains quite low with a limited operational temperature range (e.g., 100 °C). To this end, ionic liquids with high ionic conductivity and boiling points (e.g. > 200 °C) are auspicious candidates to overcome these issues. Additionally, the inclusion of highly charged colloidal nanoparticles has been shown to further enhance the Seebeck coefficient and the power output by proper tailoring.

In this work, the thermoelectric properties of ionic liquid (EMI-TFSI) based maghemite ferrofluids (colloidal suspension of magnetic nanoparticles (NP)) with tris(2,2'-bipyridine) $[Co(bpy)_3]^{3+/2+}$ redox couple were studied with varying combinations of NP surface coating molecules and counter-ions. The results shed light upon the intricate balance between the NP concentration and the solvation shell of redox salts affecting the fluids' overall TE energy conversion process and performance. A discussion on some key experimental parameters for improving the efficiency of liquid thermoelectrochemical cells will also be given.