Thermophysical Properties of New Molten Nanosalts

João Chainho, Ivo Costa, Valentim Nunes, Maria José Lourenço, João Serra and Carlos Nieto de Castro

Energy is a core topic to the mitigation of global warming and climate change. **Energy storage plays a crucial role in the development, progress and penetration of renewable energy sources**, allowing dispatchability of supply. Regarding the current situation of renewable electricity generation, dominated by solar PV and wind, **concentrated solar power (CSP) is one renewable energy technology with significant potential to increase the share of renewable electricity generation in the future.**

NEWS4CSP aims to develop and validate new solutions for thermal energy storage using new formulations of molten salt mixtures, eutectic **$(LiNaK)_2CO_3$, simply referred to as LiNaK**, with nanoparticles, and to reach simultaneously high working temperatures, high energy density and improved heat transfer rates with low corrosivity for structural materials.

There is not much data regarding the **C_p of LiNaK** (with or without nanoparticles) and for those who report it, there is conflicting data regarding the C_p of LiNaK and its behavior with temperature. This is assumed to be due to differences in methods of preparation and analysis and gases used during the measurements (Fig.1).[1-4] These properties are measured using **Differential Scanning Calorimetry** (DSC, Fig.2). Other important parameters of these salts are the thermal conductivity and density when in the liquid state, also with sparse literature available. There is a need for these data as they are important thermophysical properties to consider in applications such as these. Our lab has an **oscillation cup viscosimeter for high temperatures** (Fig.3), new platinum sensors deposited onto alumina substrates have been constructed (Fig.4), and the Wheatstone bridge developed (Fig.5) to measure the **thermal conductivity (transient hot-strip) of LiNaK** and its nanosalts with dispersed nanoparticles (SiO_2 and MgO).

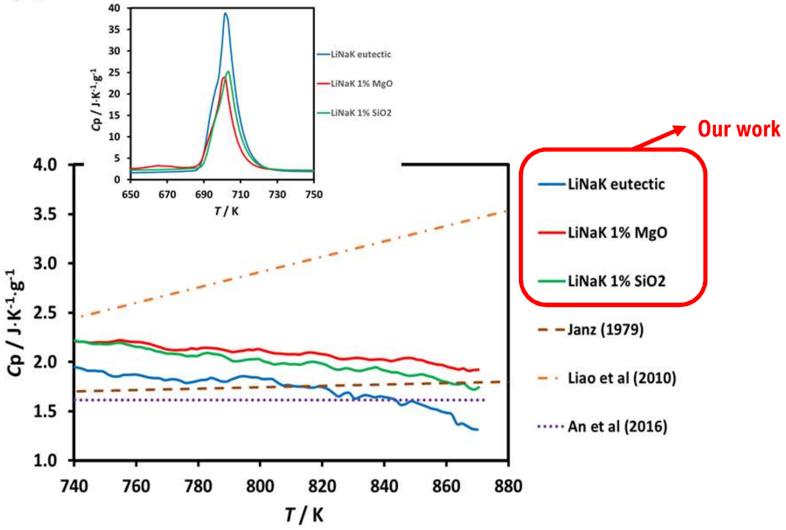

Fig. 1 – Liquid phase - Our data vs Janz (1979), An et al (2016), and Liao et al (2010). The inset shows the melting transition, sharper for the pure eutectic

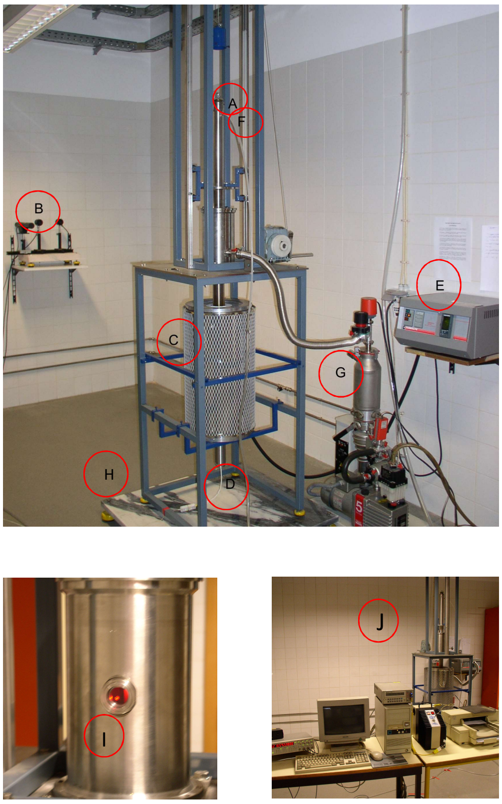

Fig. 3 – General view of the viscometer equipment: (A) oscillating initiator connected to the Pt92/W8 suspension wire; (B) He-Ne laser and photo detectors, in a vibration-free table; (C) high temperature furnace; (D) temperature measurement thermocouple; (E) furnace temperature controller; (F) inert gas intake; (G) vacuum system; (H) vibration-free table; (I) quartz window for laser beam; (J) timer interval counter, multimeter and computer for data acquisition and control.

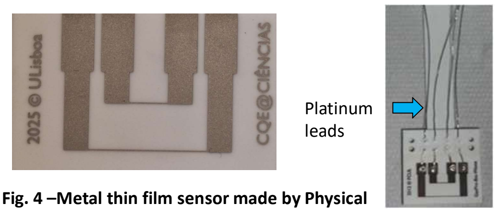

Fig. 4 –Metal thin film sensor made by Physical Vapor Deposition (PVD) of platinum on Alumina substrate

Fig. 2 – Linseis DSC PT-10 and the alumina crucibles used in measurements (top right)

Fig. 5 – Wheatstone bridge to for transient hot-strip measurements of thermal conductivity

Financed by projects UIDB/00100/2020, UIDP/00100/2020
DOI: 10.54499/UIDB/00100/2020
and
Project NEWS4CSP, 2022.05021.PTDC, DOI: 10.54499/2022.05021.PTDC

References

[1] G. J. Janz and R. P. T. Tomkins, NSRDS-NBS 61 Part IV, 1981, 1–861

[2] An, X., Cheng, J., Zhang, P., Tang, Z. and Wang, J. (2016). Determination and evaluation of the thermophysical properties of an alkali carbonate eutectic molten salt. *Faraday Discussions*, 190, pp.327–338.

[3] An, X.-H., Cheng, J.-H., Su, T. and Zhang, P. (2017). Determination of thermal physical properties of alkali fluoride/carbonate eutectic molten salt. *AIP conference proceedings*.

[4] M. Liao, X. L. Wei, J. Ding, B. H. Hu, and Q. Peng, Acta Energiae Solaris Sinca. 31, 863–867 (2010) (In Chinese).