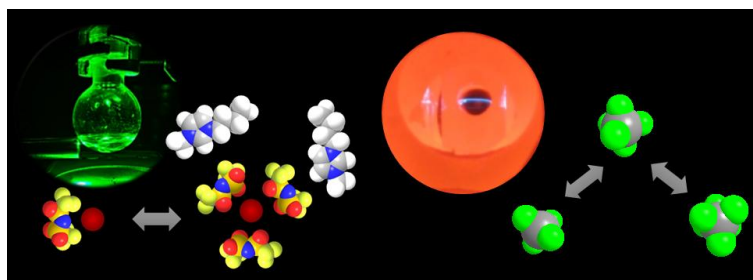


Raman spectroscopy for probing extreme chemical systems: from high-temperature molten salts to super-acidic room temperature ionic liquids

Cedric Malherbe¹, Aurelie Renzonnet¹, Gauthier Eppe¹

¹ *Laboratory of Mass Spectrometry, MolSys Research Unit, University of Liege, Belgium*

Extreme chemical systems such as high-temperature molten salts, supercritical fluids and super-acidic ionic liquids pose major analytical challenges due to their reactivity, optical opacity, volatility or limited sample accessibility. Over the past decade, Raman spectroscopy has emerged as a uniquely versatile tool for the in situ and non-destructive characterisation of such environments, provided that dedicated optical configurations, rigorous spectral modelling and advanced chemometric analysis are implemented to extract fundamental physico-chemical information and enable robust analytical developments. This contribution presents a methodological perspective based on Raman spectroscopic investigations of chemically extreme acidic systems, spanning temperatures from ambient conditions up to 1000 °C and encompassing two acidity regimes. In situ polarised Raman measurements performed on aluminium fluoride-based molten salts allow the identification of an unsuspected pentafluoroaluminate complex within the melt and enable the direct quantitative determination of melt composition under industrially relevant operating conditions^{1,2}. More recently, the methodology has been applied to non-protic ionic liquids exhibiting super-acidic behaviour, where Raman spectroscopy enables the experimental estimation of proton solvation free energies and provides direct insight into acidity levels using Hammett acidity scales^{3,4}. Beyond the specific systems investigated, this work highlights the broader potential of Raman-based methodologies for studying extreme chemical media using miniaturised instrumentation such as those developed for highly constrained environments, including space exploration.



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