Using Foam to Separate Ions: Superchaotropic Effects as a New Route toward Sustainable Chemistry

*Valentin Legrand, Coralie Pasquier, Alban Jonchère, Stéphanie Szenknect, Luc Girard, Olivier Diat, Pierre Bauduin**

Institut de Chimie Séparative de Marcoule, ICSM, CEA, CNRS, ENSCM, Univ Montpellier, Marcoule, France

pierre.bauduin@cea.fr

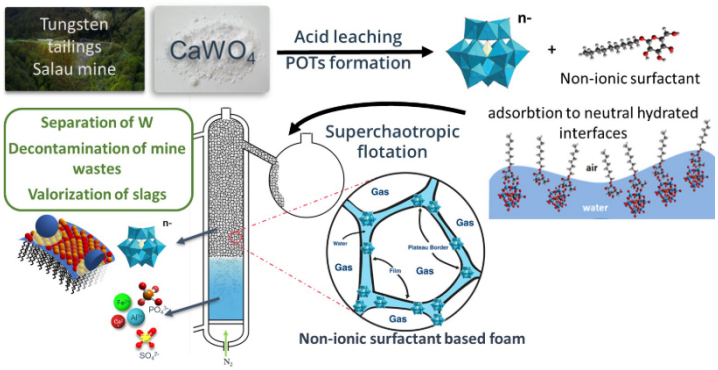
The selective separation of ions in aqueous systems is a longstanding challenge in chemistry, environmental remediation, and resource recovery. We present a novel, solvent-free strategy that leverages *superchaotropic effects* to extract anionic metal species using foam flotation.

Unlike classical ion flotation, which requires charged surfactants, superchaotropic nano-ions, such as some polyoxomolybdates and polyoxotungstates, adsorb efficiently onto non-ionic surfactant films. [1] This unexpected affinity allows their selective enrichment in foam under mild conditions, providing a sustainable platform with minimal organic content. [2]

We illustrate the feasibility of superchaotropic flotation with two systems. Molybdenum forms iso-polyoxomolybdates at low pH whose superchaotropic character drives foam-mediated separation. [2] Tungsten forms heteropolyoxotungstates with phosphate, which are also superchaotropic; importantly, these species can be generated from real mining residues, demonstrating the potential for environmental remediation and the valorization of industrial waste. [3]

These results demonstrate how the fundamental concept of superchaotropicity, introduced in 2015 [1, 4] , can now be harnessed for applied separation chemistry, bridging interfacial science with sustainable, solvent-free technologies.

Keywords:
foam, flotation, ion, separation, solvent-free



Example of superchaotropic flotation for the recovery and valorization of tungten mine tailings

References:

[1] B. Naskar, O. Diat, V. Nardello-Rataj, P. Bauduin, *The Journal of Physical Chemistry C* **2015** , *119* , 20985–20992.

[2] K. Skorzewska, A. Jonchère, C. Pasquier, L. Girard, P. Bauduin, *Separation and Purification Technology* **2023** , *323* , 124284.

[3] a) V. Legrand, S. Szenknect, O. Diat, L. Girard, P. Bauduin, *Hydrometallurgy* **2025** , *237* , 106538; b) V. Legrand, University of Montpellier **2025** .

[4] K. I. Assaf, M. S. Ural, F. Pan, T. Georgiev, S. Simova, K. Rissanen, D. Gabel, W. M. Nau, *Angew Chem Int Ed Engl* **2015** , *54* , 6852–6856.