Development of lipophilic ligands such as aminopolycarboxylic acids for the separation of actinides and lanthanides

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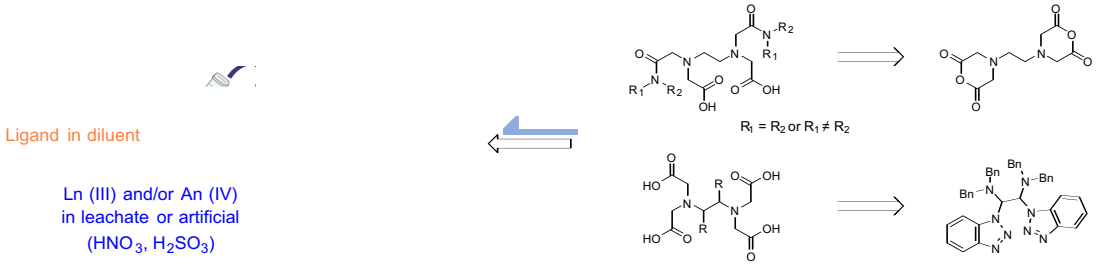
In the context of the energy transition, recycling strategic metals is a vital and sustainable supply solution. More specifically, optimizing the existing recycling processes of the spent nuclear fuel and other wastes for recovering valuable actinides and lanthanides from effluents is crucial for a circular economy.[1] Recycling is achieved via hydrometallurgical processes that rely on liquid-liquid extraction (LLE)[2] enabled by specific ligands. Such processes still face challenges in selectivity, efficiency, and operational simplicity. A key opportunity lies in modifying or replacing extractants to enhance performance.[3]

In line with this approach, this study introduces the "molecular cross-dressing" concept: the conversion of initially water-soluble compounds into lipophilic derivatives to create extractants that enable selective metal separation via LLE processes. Aminopolycarboxylic acids (APCAs) were targeted because of their strong affinity for lanthanides and actinides in aqueous media. Their lipophilic analogs were expected to almost promote the efficient transfer of these metals in the organic phase whereas the selectivity of the extraction was predicted to strongly depend on the achieved chemical modifications.[4] This work describes the synthesis of a series of new lipophilic EDTA derivatives and their assessment for the LLE of lanthanides and uranium. The transformations involve amidation[5] with fatty *N*,*N*-dialkylamines or tailoring the hydrocarbon skeleton[6] of APCAs. Number, length, degree of branching, and nature (aliphatic or aromatic) of the alkyl chains are adjusted so as to generate, initially, lipophilic analogues featuring acceptable (> 0.1 M) solubility in oil. Further structural adjustments are then made in order to optimize the extraction performance of the ligand under study. Modified EDTA derivatives could be formerly applied to the selective recovery of rare earths contained in non-nuclear effluents.[7]



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