

Specific Ion Effects in Lanthanide–Amphiphile Structures at the Air–Water Interface and Their Implications for Selective Separation

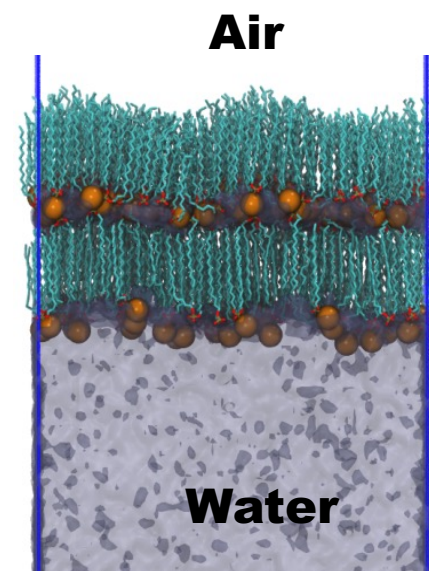
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Solvent extraction is the only commercialized approach for the selective separation of lanthanides, where lanthanides are transported from water phase, across water-oil interface, to oil phase. Water-oil interface is associated with the free energy barrier of the transport process, which is, nevertheless, barely understood owing to limited experimental techniques. Water-air interfaces are thus frequently employed as simplified models for the water-oil interface.

Lanthanides (Ln) refer to a group of heavy metals from $_{57}\text{La}$ to $_{71}\text{Lu}$. They are essential for a broad variety of modern techniques, ranging from smart phone, hybrid/electric vehicles, to aircraft. The selective separation between Ln is thus of paramount interest, whereas, highly challenging owing to their similar physical and chemical properties.

In collaboration with Prof. Dutta, we found that non-water soluble amphiphiles (DHDP) formed bilayer structures (figure on the right) in the presence of heavy lanthanides (atomic number ≥ 65). In contrast, only DHDP monolayer was observed in the presence of light lanthanides. Atomistic simulations demonstrated that $_{68}\text{Er}$ are highly dehydrated in the sandwiched region in the bilayer structure, where a higher Er-DHDP coordination was observed. It thus sheds insights into the favored separation for heavy lanthanides in solvent extraction.



DMDP (cyan) forms bilayer at water-air interface in the presence of heavy lanthanide Er^{3+} (orange)