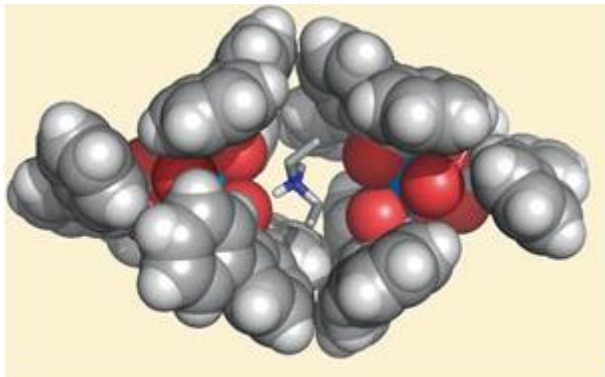


## Uranium from Seawater

### [New Research on Extracting Uranium from Seawater using Self Assembled Ligands](#)



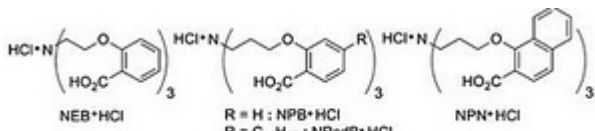
Carboxylic acid ligands coordinate to the ion forming a cage around it

[US scientists have devised a new way to extract uranyl ions from aqueous solutions.](#) There are 4.5 billion tons of uranium in seawater which is about 1000 times more than current conventional reserves.

[Japan has been looking at getting large quantities of uranium from seawater using bioengineered seaweed](#) and [previous field trials with ionized polyethylene.](#)

Although uranium is currently extracted from solid ores such as uraninite, it also exists in large quantities as uranyl ions ( $\text{UO}_2^{2+}$ ) in seawater. However, due to its distinctive shape that prevents the use of conventional chelating ligands, sequestering the uranyl ion from seawater has remained a challenge.

The uranyl ion binds well with carboxylates, and encasing the ion in an apolar environment stabilises electrostatic interactions and enhances intermolecular forces explains Julius Rebek Jr at Scripps Research Institute in La Jolla. Rebek's team discovered that when three bidentate 2,6-terphenyl carboxylic acid ligands coordinate to the ion, their bulky phenyl groups form a cage around it shielding it from any water. This complex can then be extracted from solution in various ways depending on the type of medium it is in.



Tripodal ligands that bind uranyl ion with ammonium sites for uranyl oxygen recognition.

[The full article](#) Encapsulation of the uranyl dication [is available online.](#)

We report here the application of self-assembly to the sequestration of uranyl ion, the dominant form of uranium on Earth. The assembly presents the ion with convergent carboxylate ligands, isolates it from solvent, encapsulates it with aromatic panels and allows its extraction from aqueous solutions in the presence of excess brine.

Reversibly assembled capsules have been extensively developed for anionic, cationic and neutral guest species and the aromatic panels that define the space provide a hydrophobic cavity within the host. The synthesis and assembly of well-defined cavities that bear endohedral or inwardly-directed functional groups are much less familiar.<sup>37</sup> This is a consequence of the difficulty in performing reactions that result in functional groups—Lewis acids and bases—on concave molecular surfaces. Naturally-occurring receptors overcome this difficulty by arranging functional groups on a linear backbone then folding them around the target in a way that isolates the target from the medium and confronts it with the functional group. We have shown here that three 2,6-terphenyl acid ligands can present a  $\text{UO}_2^{2+}$  ion with carboxylate functions and surround it with aromatic panels. The hydrophobic environment and edge-to-face  $\pi$ -stacking of the capsule dramatically influences the solubility and kinetic stability of the resulting complex: the  $\text{UO}_2^{2+}$  ion can be extracted from aqueous solution even in the presence of considerable quantities of NaCl, and shows slow exchange of ligands on the 1-D NMR timescale. Given that some of the most versatile capsules use Pd or Pt ions in their assemblies,<sup>9</sup> it may be prudent to consider capsule formation as a general means of precious metal sequestration. It is anticipated that these new chelating agents will selectively bind and sequester the uranyl ion from a variety of environments.

#### Further Reading

[11 page of supplemental material with extraction and titration studies.](#)

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