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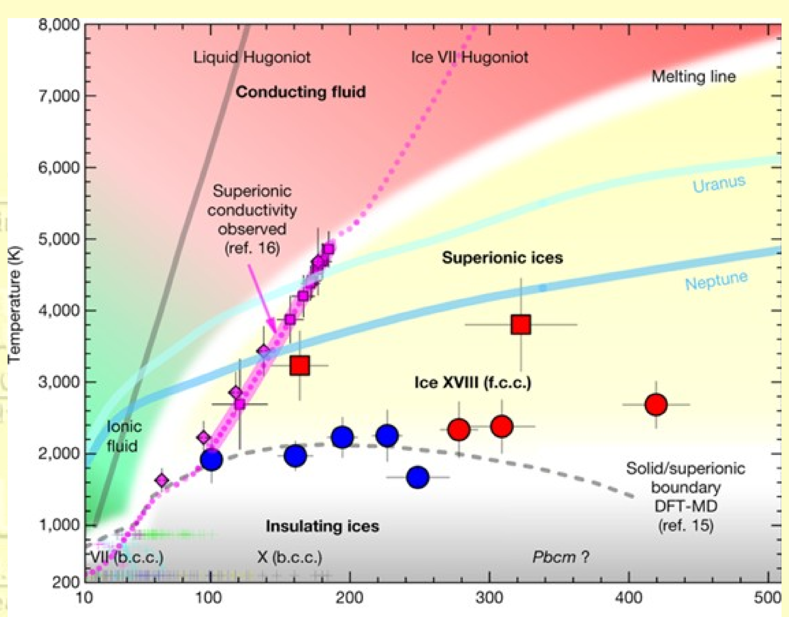
Un gel superiònic

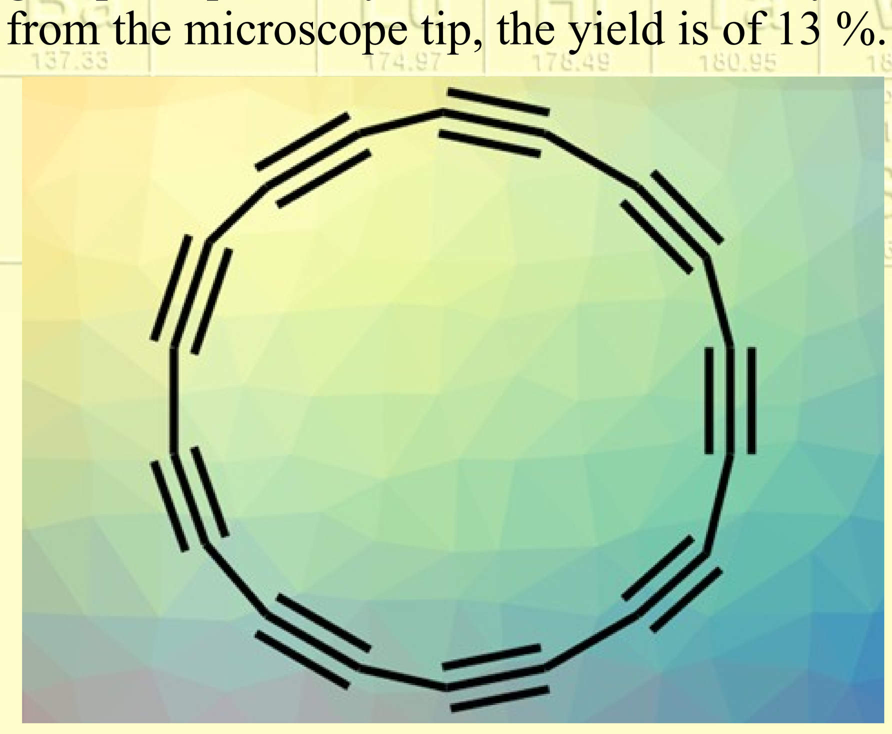
For the first time, scientists have observed an exotic form of water called superionic ice, a feat some thought impossible (M. Millot et al., *Nature* **2019**, DOI: 10.1038/s41586-019-1114-6). Water ice has 18 possible crystalline arrangements, depending on temperature and pressure. Theoretical work predicted a particularly strange structure would form at very high temperatures and pressures. In this superionic ice, the oxygen atoms are closely packed and locked in place, while protons can move through the lattice, similar to atoms and electrons in a metal. Decades after it was first predicted, scientists have finally observed it in the lab.
Although it was thought that it would be nearly impossible to experimentally create the necessary conditions for superionic ice, the team fired six laser beams at a thin layer of water in a 15 ns sequence, generating shock waves that reverberated between diamond plates holding the samples. At temperatures near 2,000 and 3,000 K and pressures between 160 and 420 GPa, X-ray diffraction (XRD) indicated the formation of face-centered cubic crystals of superionic ice, which the researchers are calling ice XVIII. The researchers say the extreme experimental conditions are the same ones found deep inside icy planets like Neptune and Uranus, raising the possibility that superionic ice may exist in nature.



H_2O phase diagram

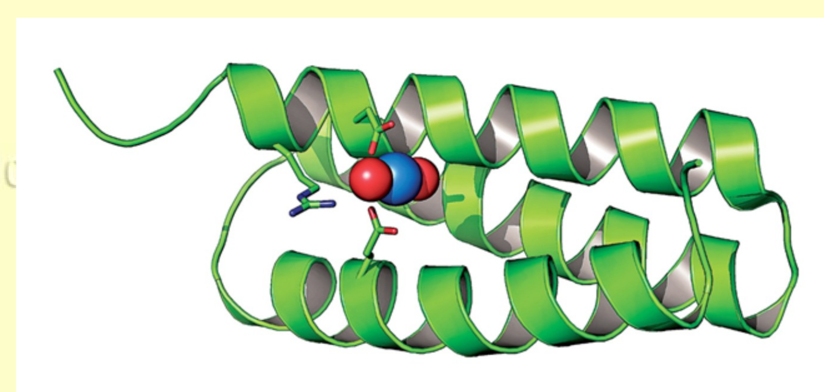
Manipulacions atòmiques porten al C_{18}

Carbon exists in many forms such as diamonds, graphite, graphene, fullerenes, and carbon nanotubes are well-known allotropes. Rings of 2-coordinate, sp-hybridized carbon atoms have been suggested as another possible form. However, due to their high reactivity, such rings had not been isolated or characterized outside of the gas phase so far. Now, a team (K. Kaiser et al., *Science* **2019**; DOI:10.1126/science.aay1914) have synthesized such the ring: cyclo[18]carbon, using low-temperature scanning tunneling microscopy and atomic force microscopy (STM–AFM) to prepare the compound on an NaCl surface. They started from the cyclocarbon oxide $C_{24}O_6$ as a precursor and removed the six CO groups sequentially. This was achieved by manipulating the atoms using voltage pulses from the microscope tip, the yield is of 13 %.



Pescant urani

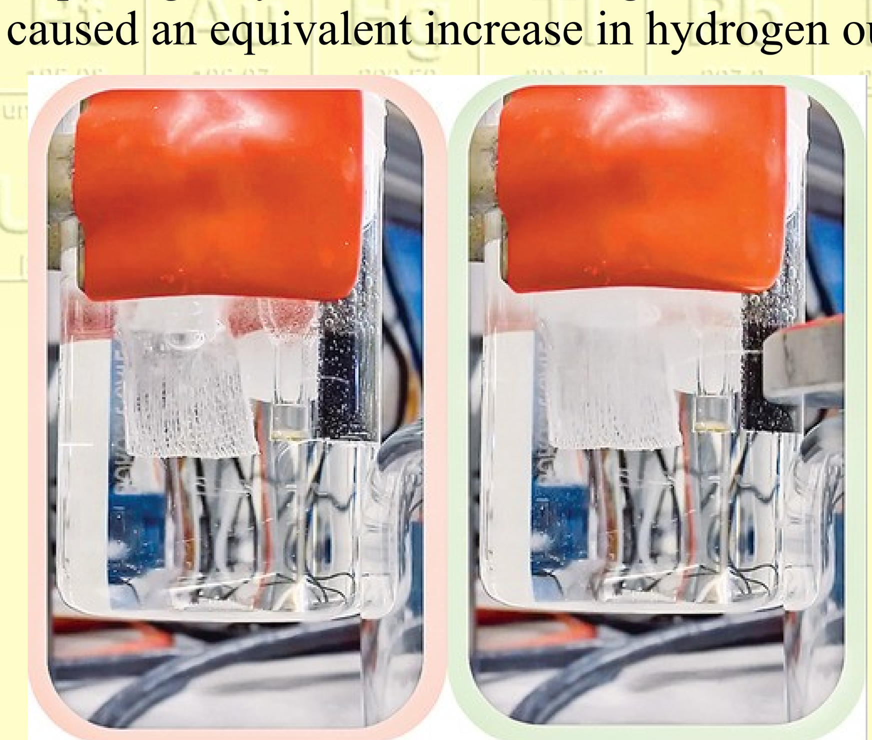
The world's oceans contain more than 4 billion metric tons of dissolved uranium, a reserve 1,000 times as great as terrestrial deposits. Scientists would like to tap this almost-limitless fuel supply for nuclear reactors, but uranium's low concentration in seawater—just 3.3 ppb—makes it a formidable challenge to extract the valuable element. Researchers in China (Ning Wang et al., *Angew. Chem., Int. Ed.* **2019**; DOI:10.1002/anie.201906191) hope that some new fishing gear will help land this prize catch. They have combined synthetic spider silk and a uranium adsorbing protein to make strong threads with the highest uranium-uptake capacity of any fiber adsorbents tested in natural seawater. The team settled on a super-uranyl-binding protein (SUP) that is over 10,000 times as selective for uranyl as other ions in seawater, and it was fused with spidroin, the main protein found in spider silk. The researchers pumped seawater over their protein for 3.5 days. In that time, each gram of the fiber had extracted 12.33 mg of uranium. The spider silk fishing line was thousands of times as selective for uranyl than 13 other metal ions, including vanadyl. To strip out the uranium, the researchers washed the loaded fiber with EDTA. The fiber retained about 90% of its original adsorption capacity after five rounds of uranium fishing and washing, but this dropped below 70% of the original capacity after 10 cycles.



This super-uranyl-binding protein (green) can hook uranyl ions (UO_2^{2+}) from seawater. Uranium = blue, oxygen = red

L'imant que ajuda a trencar l'aigua

Using nothing more than a $10 magnet, researchers at the Institute of Chemical Research of Catalonia (ICIQ), (J. Galán-Mascarós et al., *Nat. Energy* **2019**; DOI: 10.1038/s41560-019-0404-4) have doubled the hydrogen output of a water-splitting electrolyzer. If the approach can be scaled up, it has the potential to slash the cost of producing hydrogen from water, making this route to hydrogen more attractive. Only 4% of hydrogen is made by the electrolysis of water, largely because the process is so expensive. Alkaline water electrolyzers typically contain a solution of potassium hydroxide and two nickel based catalytic electrodes separated by a porous membrane. The team focused on the oxygen-evolution reaction, the slowest part of this process; they coated a nickel foam anode with magnetic nickel zinc ferrite and used it in an electrolyzer running at about 1.6 V. When they placed a commercial neodymium magnet next to the anode, it roughly doubled the current density at the anode without requiring any additional voltage. This doubled the rate of oxygen production and caused an equivalent increase in hydrogen output.



A gently bubbling electrolyzer (left) suddenly doubles its output of hydrogen and oxygen when a magnet is placed next to the anode (right), suggesting a simple way to make hydrogen more efficiently.

Breus

- El 8 de maig d'enguany el CAS va registrar el compost número 150.000.000. La velocitat de creixement és espectacular, van caldre 40 anys per arribar als 25 milions l'any 2005, i en els últims 4 anys se n'han obtingut 50 milions més. (*Chem. Eng. News.*, **2019**, 97(22), 43)
- El web *ChemRxiv*, establert l'any 2017, que recull manuscrits que els autors sometent a l'opinió d'altres col·legues abans d'enviar-los a l'editor d'una revista (open preprint), ha arribat als 2.200 documents procedents de 70 països. Han estat comentats i baixats més de dos milions i mig de vegades, i 1.200 d'ells han aparegut publicats en revistes convencionals.
- **IYPT 2019**: El número 31, del 5 d'agost, del *Chem. Eng. News.* recull cinc articles, molt interesants, de científics, poetes i artistes sobre la seva visió personal de la Taula Periòdica.

Avui recomanem

L'article "The most boring chemical element. Could it be boron or bohrium that is the most boring? You'll need to read to the end to find out." de Rebecca E. Jelley i Allan G. Blackman, *Nature Chemistry,* **2019**, 11, 751-756; DOI: 10.1038/s41557-019-0307-9. Es fa una anàlisi completa dels elements –individualment i per grups de la Taula– molt innovadora, il·lustrativa i estimulant per tal de respondre la pregunta del títol.

L'element

L'element numero 88, **radi**, fou descobert l'any 1898 per Marie i Pierre Curie en el mineral uraninita –o pechblenda– format principalment per UO_2, procedent de Bohèmia. A partir de 10 Tm del mineral en van obtenir 1 mg. Posteriorment, l'any 1911, Marie Curie i Andrè Debierne, per electròlisi d'una solució del clorur amb elèctrodes de mercuri i destil·lació, en atmosfera d'hidrogen, de l'amalgama formada van aïllar l'element pur. El nom li posà Marie Curie, pels raigs (radii) blaus que emetia. Es coneixen 33 isòtops, tots ells radioactius; quatre dels quals es troben a la naturalesa ^{223}Ra (vida mitjana: 11,4 dies), ^{224}Ra (3,64 dies), ^{226}Ra (1600 anys) i ^{228}Ra (5,75 anys). Inicialment, a la primera meitat del segle XX, s'emprava en el tractament del càncer, però atesa la seva perillositat –produeix cremades a la pell– ha estat substituït per altres elements menys nocius com el ^{60}Co. Poc després del seu descobriment fou molt popular en considerar que les radiacions que emetia eren beneficioses per a la salut i es venia en diverses maneres i formulacions; fins i tot l'aigua mineral "Vichy Catalán" en donava la seva radioactivitat a l'etiqueta.