

WITH RISING DEMAND FOR SUSTAINABLE AND CLEAN ENERGY SOURCES, RESEARCHERS DEVELOP AN INNOVATIVE MATERIAL TO EXTRACT URANIUM FROM SEAWATER

URANIUM FOR TOMORROW

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IN the quest for sustainable and abundant energy resources, the extraction of uranium from seawater has emerged as a promising avenue. Uranium, a key component in nuclear fuel, is traditionally obtained from terrestrial ores. However, as demand for nuclear energy rises and concerns about the environmental impact of conventional mining grow, researchers are exploring innovative methods to harness the vast uranium reservoirs present in seawater.

Seawater is an immense reservoir of uranium, with estimates suggesting that it contains approximately 4.5 billion metric tons of this valuable resource. While the concentration of uranium in seawater is low – about 3 parts per billion – it represents a virtually limitless supply compared to the finite terrestrial uranium deposits. Several techniques have been explored to extract uranium from seawater, each with its advantages and challenges. The most common modes include absorption onto materials like amidoxime-based polymers, ion exchange resins and advanced materials like metal-organic frameworks (MOFs).

A recent breakthrough published in ACS Central Science introduces a novel material designed to significantly en-

hance the electrochemical extraction of hard-to-get uranium ions from seawater. To create their electrode, Rui Zhao, Guangshan Zhu and team began with flexible cloth woven from carbon fibre. This cloth then underwent a coating process involving two specialised monomers, subsequently polymerised for stability. Following this, hydroxylamine hydrochloride treatment was applied to introduce amidoxime groups to the polymer cloth. The inherent porous nature of the cloth facilitated the creation of numerous minuscule pockets, providing an ideal environment for amidoxime to easily entrap uranyl ions.

In the experimental setting, the researchers utilised the coated cloth as a cathode in seawater obtained either naturally or spiked with uranium. A graphite anode was introduced, and a cyclic current was established between the electrodes. Over time, bright yellow, uranium-based precipitates accumulated on the cathode cloth. Upon reaching its saturation, the cloth undergoes a chemical treatment process to release the uranyl. Subsequently, the liberated uranyl must further undergo refining procedures akin to those employed for ore extracted from a conventional mine, before it can be utilised in reactors.

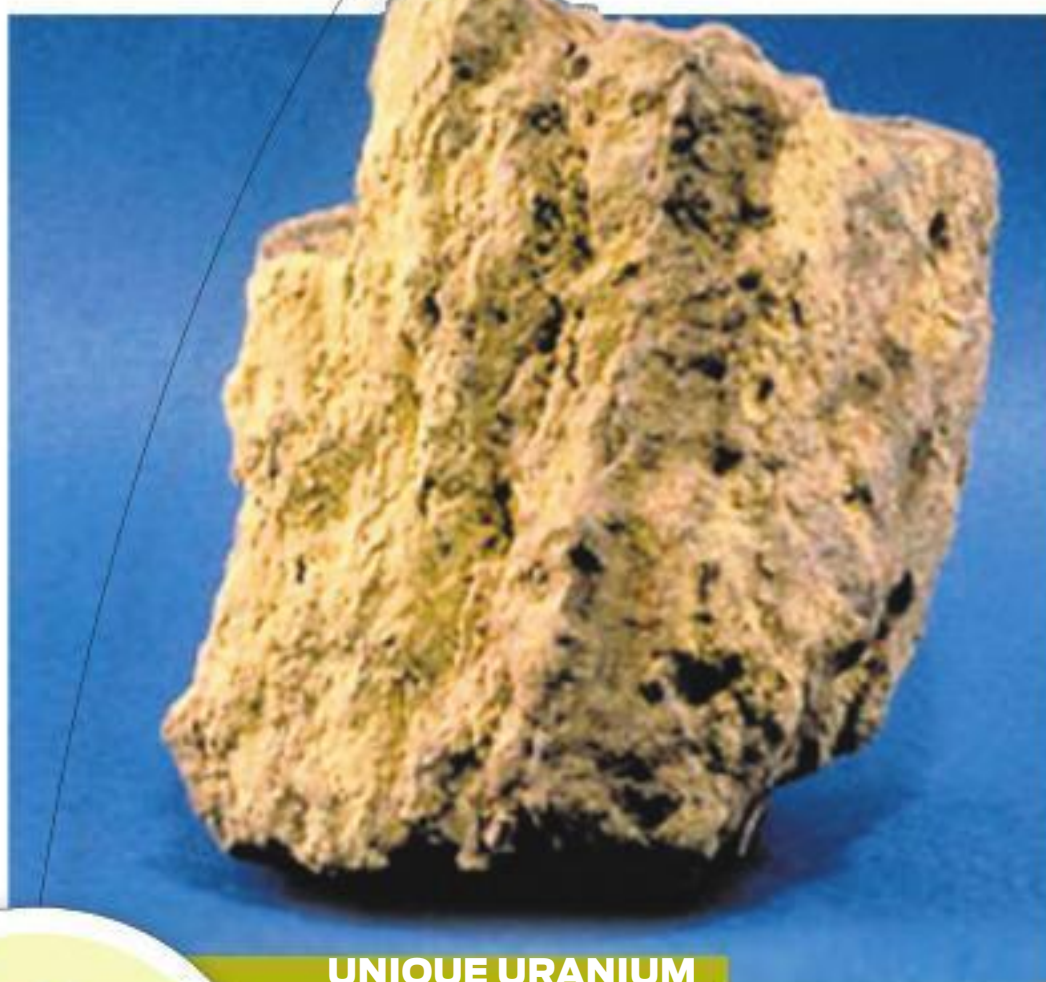
In the tests using seawater sourced from the Bohai Sea,

near Northern China, the electrodes extracted 12.6 milligrams of uranium per gram of the coated active material within a 24-day period. The capacity of the coated material surpassed that of the majority of the other materials tested for uranium extraction by the team. Additionally, the application of electrochemistry for ion entrapment proved to be approximately three times faster than the natural accumulation process on the cloth.

Pros and cons

The advantages of this material lie in its simplicity, affordability, reusability and eco-friendly nature. It does not require any chemical additives or catalysts, and does not generate any harmful by-products or waste. Moreover, it also has a high selectivity for uranium over other metals and ions in seawater.

Nevertheless, it harbours certain drawbacks that impede its practical utilisation and scalability. Since there is a low uranium concentration in seawater, the material needs to be deployed in large volumes of water to achieve significant uranium extraction, hindering its efficiency. The material's sensitivity to the pH and salinity conditions of seawater also impacts its stability and performance.



UNIQUE URANIUM

Uranium (symbol U and atomic number 92) is a silvery-grey metallic element in the actinide series of the Periodic Table

- A uranium atom has 92 protons and 92 electrons, of which 6 are valence electrons. Uranium radioactively decays by emitting an alpha particle

- The most common isotopes in natural uranium are uranium-238 (which has 146 neutrons and accounts for over 99% of uranium on Earth) and uranium-235 (which has 143 neutrons)

- Uranium has the highest atomic weight of the primordial occurring elements, with a density about 70% higher than that of lead and slightly lower than that of gold or tungsten

- It occurs naturally in low concentrations of a few parts per million in soil, rock and water, including seawater, and is commercially extracted from uranium-bearing minerals such as uraninite

A NEW POSSIBILITY

THE researchers assert that their work presents a highly effective technique for capturing uranium from seawater, potentially unlocking the oceans as novel reservoirs of nuclear fuel. The heightened efficiency and capacity of the developed electrodes position them as promising candidates for widespread implementation, contributing to the economically feasible extraction of uranium. The findings hold significant implications for the future of nuclear energy



Simply

SCIENTIFICO

Science is a world in itself. Here are some interesting facts that connect with you

Nirad Mudur

conducted researches pointed to dolphins having a capacity to remember 20 years back in time, and ravens preferring to memorise who tricked them, a thorough study by University of California-Berkeley (UCB) researchers on bonobos and chimpanzees has revealed that recall in these apes can go much further than dolphins. The researchers chose pairs of chimpanzees and bonobos from zoos in Europe and Japan, and with the help of zoo authorities, identified which among them had been with the other and how many years ago. They recorded the years of separation of each pair. The primates in the study group were then shown images of their former companions as well as strangers, while using infrared eye-tracking cameras to record their eye movements when they saw the images. What they discovered was that the gaze of the chimpanzees and bonobos under study lingered on longer when the images of their long-separated buddies came up. But not when strangers came up. One of the bonobos, a female, homed in on the image of her 26-years-separated sister. These reactions were recorded even as the chimps were treated to their favourite fruit juices.

NIGHT VISION

THE WONDER SIGHT OF RUDOLPH THE RED-NOSED REINDEER

It's the season in which "Rudolph the red-nosed reindeer" is most sung about. But this time around, Rudolph and his reindeer brethren have especially become the focal centre for researchers from Dartmouth and the University of St Andrews in Scotland. They have solved the mystery behind how a reindeer is able to see its staple food, a lichen called *Cladonia rangiferina*, a species of fused algae-fungus, which is white in colour and impossible for the human eye to spot in the white snow, where it grows during winters. But it's visible to the reindeer's eye, and 'why' and 'how' is what the scientists have discovered. They found that reindeer's eyes have evolved through mutation to spot their staple which remains perfectly camouflaged to human vision, but not to theirs. The team used the spectral data from the lichen and calibrated light filters to mimic reindeer vision and found that these lichens appear to reindeer as dark patches in the background of the white snow in the nights, making it easy for the reindeer to sight them. They found that a reindeer's light-enhancing membrane in the eyes changes in winters from a golden colour that most animals have to a clear blue that amplifies the low light of polar winter.

[illegible]

Arogyamandir

Health - Problem and Solution

Q. How does Rhutcharya i.e. seasonal regimen benefit health? What is Visarga & Aadan Kala as per Ayurved?

Ans - Every Rhythu i.e. season has a certain regimen that must be followed to maintain harmony or balance of the Tridoshas in the body. This systematic seasonal regimen includes diet & lifestyle recommendations, which are mentioned in the Ayurvedic texts. These seasonal regimen help to prepare the body to cope up with the environmental changes and protect one's health & wellbeing. There is a distinct division of Kala into two, Visarga & Aadan, according to the movement of Sun. Visarga Kala is also known as Dakshinayan, the period when the sun gradually moves towards the south and Aadan or Uttarayan is when the Sun gradually moves towards the north. The three seasons clubbed under Visarga Kala are Varsha (Rainy), Sharad (Autumn) & Hemant (Winter), wherein the Bala that is strength of the body increases with every passing month and the Jatharagani is well ignited towards the end. Aadan Kala comprises of Shishir (late winter), Vasant (Spring) and Greeshma (Summer) where the strength of body gradually depletes. Hence, season play an important role in the health and one must make changes in their routine to seamlessly get acclimatized the seasonal changes.

Q. What are the dietary recommendations to prepare the body for winter months, according to Ayurveda?

Ans - During winter months, the cold, harsh and dry winds may create "Rookshata" i.e. dryness in the body if adequate care isn't taken. Also, the strength of Jatharagni is at its peak during winter months which ensures proper digestion.

Make sure to have food items which are nourishing, warm, rich in healthy fats such as Cow Ghee, Dry fruits like Almonds, Walnuts, Pistas, Dates, Makhana, Pumpkin Seeds, Sesame Seeds, Khush Khush (Poppy seeds), Jaggery, Milk etc. Use of spices such as Cinnamon, Cloves, Pepper corns, Bay leaf, Anise help ensure healthy digestion of the heavy food consumed. Having Ushnodak (water boiled and reduced to half) can be practiced during this season and preferably warm beverages like turmeric milk, hot water, soups may be consumed regularly. During this season, having a suitable Rasayan like Swamala Compound, that contains finest Amlas, cow Ghee, honey and potent Ayurvedic herbs helps the body. Start with 1 teaspoonful in children above 12 years and for adults 1 tablespoonful morning and evening on empty stomach.

Q. What is Oja? Why is it significant and suggest tips to stay healthy?

Ans - According to Ayurved science, Oja is the most precious part which evolves from the essence of all the seven body tissues (Sapta Dhātu). Oja gives strength to body and mind. Oja is responsible to maintain Vyadhikshamatva (immunity) which prevents infections from external factors and protects from recurrent sickness. Have a Shadrasatmak Ahar (meal which comprises all six tastes such as Sweet, Salty, Pungent, Astringent, Bitter and Sour) which ensures that all essential nutrients are received. Make it a point to include Vyayam i.e. exercise and Pranyama i.e. breathing practices in daily routine to channelize the energy and keep the body as well as mind fit and strong. Also, Swamala Compound, Chyavanprash fortified with Gold has Oja enhancing properties and may be consumed daily to seek its health benefits.

It is appropriate to take medicines with the advice of Ayurvedic physician.

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