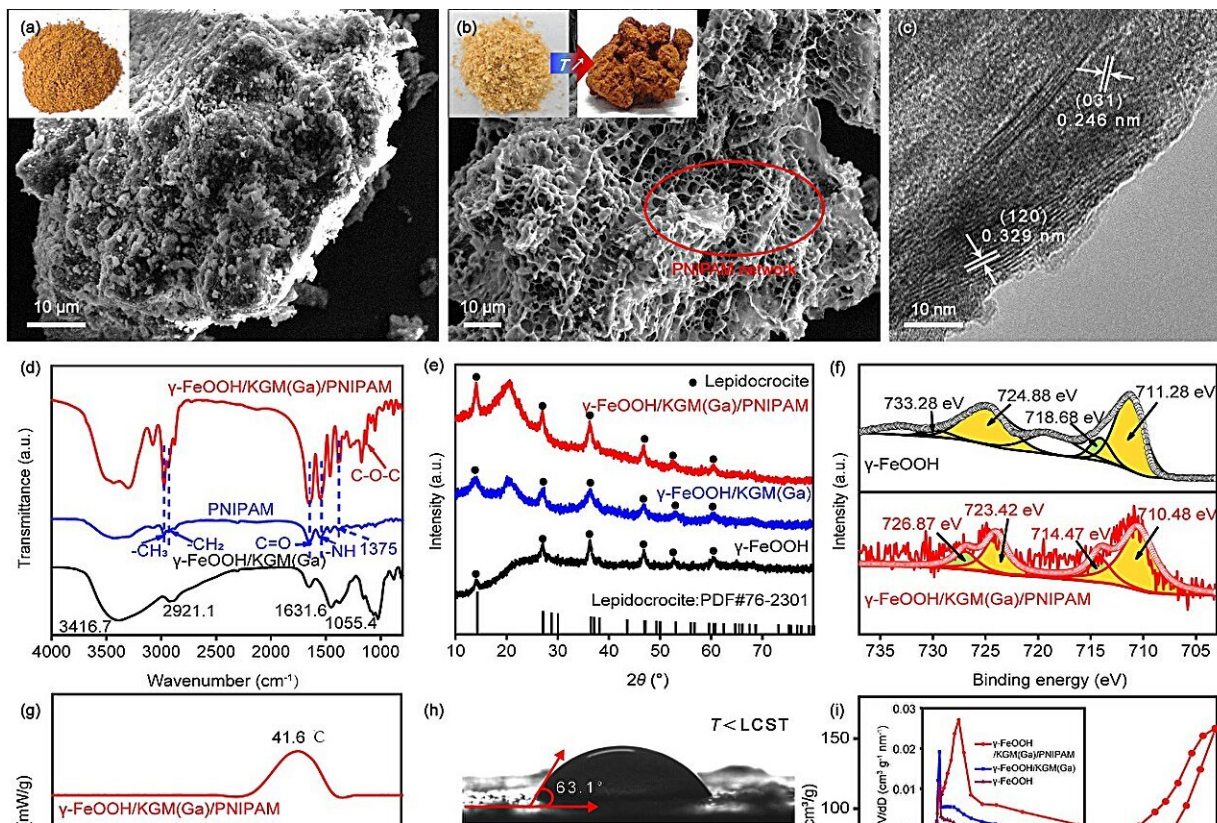


Sol-gel transition effect based on thermosensitive hydrogel shows promised for photo-assisted uranium extraction

August 27 2024



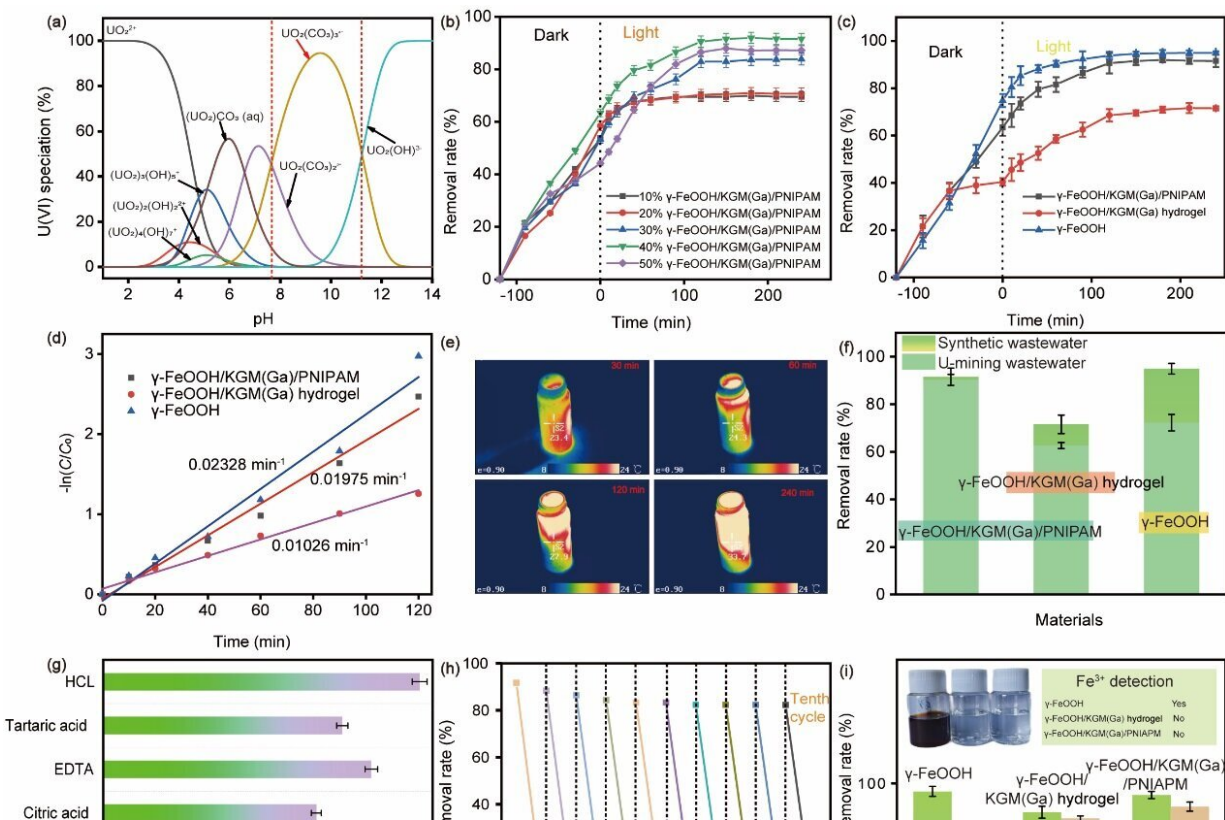
Through a series of characterizations of γ -FeOOH microgel and γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel, it is demonstrated that the composite thermosensitive hydrogel has been successfully synthesized, and that the γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel exhibits a tunable phase transition effect based on temperature changes. Credit: Wenkun Zhu and Tao Chen

To achieve carbon reduction goals, reducing emissions is crucial, and nuclear power plays a key role in providing reliable, low-carbon electricity, aiding carbon neutrality. However, the nuclear industry faces the significant challenge of managing uranium-containing wastewater, a byproduct of fuel production, nuclear plant operations, and facility decommissioning.

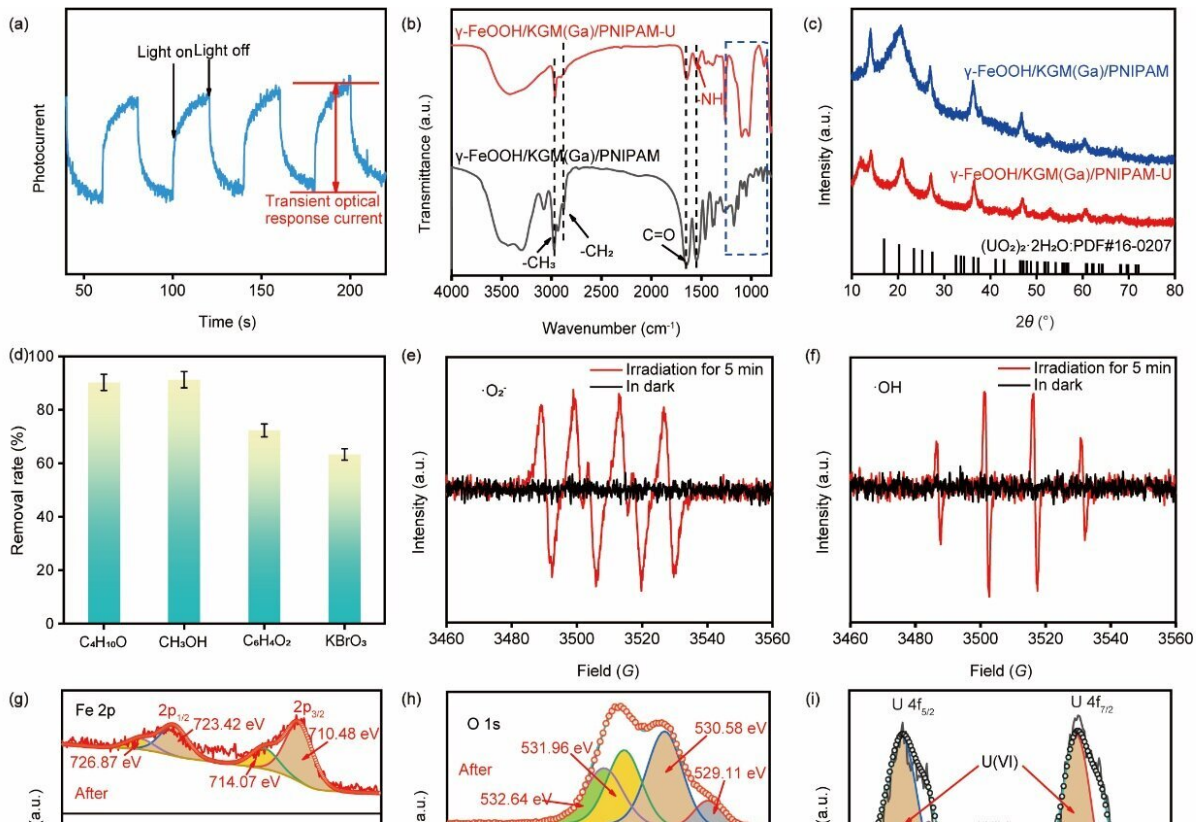
Due to the strong coordination properties of uranyl ions (UO_2^{2+}) with carbonate ligands, carbonate-containing complexes easily form in wastewater, complicating [uranium enrichment](#) and removal. Therefore, new uranium extraction technologies are needed to replace traditional adsorption and membrane separation techniques for removing and recovering uranium from carbonate-containing uranium wastewater.

Photo-assisted uranium extraction is an emerging technology that uses photo-generated electrons to drive accelerated extraction kinetics and selectively extract uranium from carbonate-containing uranium wastewater, avoiding non-reductive coexisting ions. Traditional photocatalysis mainly relies on powdered nano-photocatalysts, which are difficult to separate from the reaction medium, limiting practical application.

To address this issue, a research team led by Wenkun Zhu and Tao Chen has investigated hydrogels as photocatalytic carriers, combining a novel strategy with intelligent thermosensitive materials that dynamically change their physical state at different temperatures. This approach resolves the contradiction between high contact area during the reaction and easy recovery afterward.



The performance of γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel was tested in carbonate-containing wastewater and real uranium mine wastewater. The results showed that γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel exhibited excellent uranium removal capability in both carbonate-containing wastewater and real uranium mine wastewater. Credit: Wenkun Zhu and Tao Chen



The adsorption-reduction-nucleation-crystallization mechanism of uranium on γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel was revealed by electron spin resonance, free radical capture, X-ray photoelectron spectroscopy, and so on. Credit: Wenkun Zhu and Tao Chen

The team's study is [published](#) in the journal *Science Bulletin*.

The researchers demonstrated that the introduction of the thermosensitive material PNIPAM enables the dynamic phase transition of γ -FeOOH/KGM(Ga) microgels from a dispersed state with high specific surface area at low temperatures to a stable aggregated state at high temperatures. The γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel exhibited an excellent ability to remove up to 92.3% of uranium from carbonate-containing wastewater. Even in uranium mine

wastewater, it maintained over 90% uranium removal efficiency.

Using [electron spin resonance](#) (ESR) and radical trapping experiments, the researchers confirmed that the γ -FeOOH/KGM(Ga)/PNIPAM thermosensitive hydrogel captures dissociated uranyl ions through oxygen-rich functional groups and subsequently reduces and immobilizes uranium via reactive species such as e^- and $\cdot O_2^-$.

This study provides a promising solution for developing high-performance intelligent photocatalytic hydrogels for treating uranium-containing [wastewater](#).

More information: Xudong Wu et al, Sol-gel transition effect based on konjac glucomannan thermosensitive hydrogel for photo-assisted uranium extraction, *Science Bulletin* (2024). [DOI: 10.1016/j.scib.2024.07.005](#)

Provided by Science China Press

Citation: Sol-gel transition effect based on thermosensitive hydrogel shows promised for photo-assisted uranium extraction (2024, August 27) retrieved 27 August 2024 from <https://phys.org/news/2024-08-sol-gel-transition-effect-based.html>

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