Effective Uranium (VI) Sorption from Alkaline Solutions using bi-Functionalized Silica-Coated Magnetic Nanoparticles

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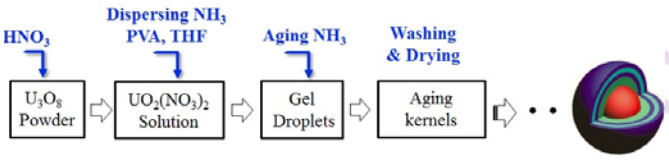
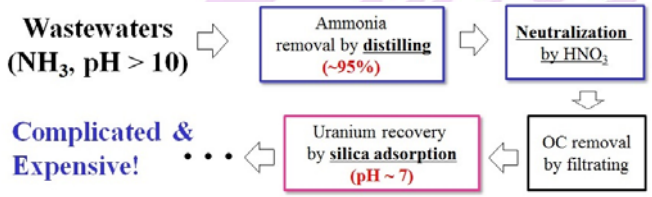
Introduction



pH	Uranium (mg/L)	Ammonia (g/L)	Organic compounds (mg/L)	NH_4NO_3 (g/L)
10.2	1~10	~100	$>10^4$	>10

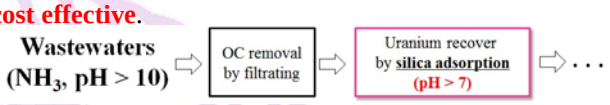
- A large amount of basic wastewater are produced with **U(VI)** and **high concentration of NH_3/N (pH > 10)** in HTR fuel processing.



- Uranium removal has to be pre-treated by NH_3 **distilling** and further **neutralizing** if ordinary sorbents are applied.

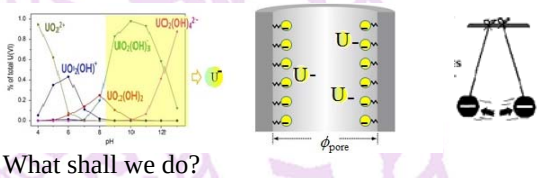
Q1: What if a sorbent material is used that can **recover uranium at pH > 7**?

A1: The process will be of **lower radioactive risk and cost effective**.



Q2: Is there any difficulty to develop such a material?

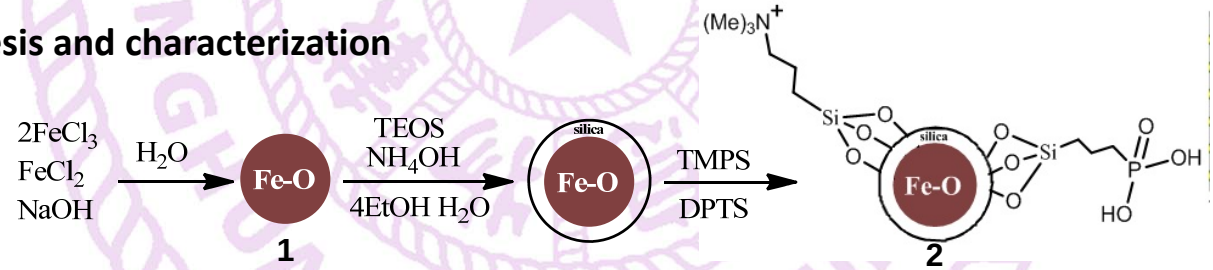
A2: Yes. When pH > 7, the **electrostatic repulsion** between the deprotonated functional groups and negatively charged U(VI) species **will be stronger**.

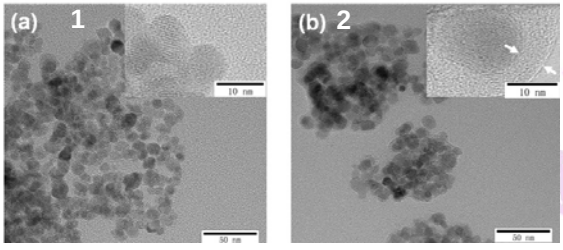


Q3: What shall we do?

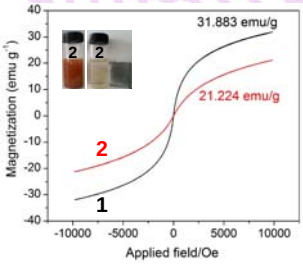
A3: **Bi-functionalized sorbents**, which are covalently bound by positively charged groups and U(VI) chelating groups are designed for uranium recovery at pH > 7.

Synthesis and characterization

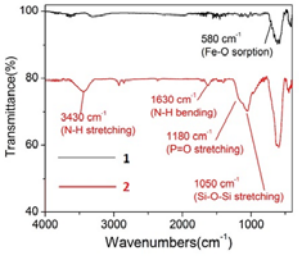




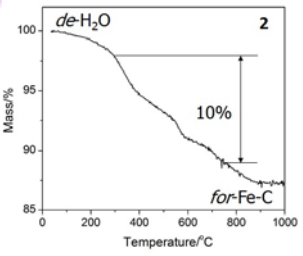
TEM images



Magnetization curves

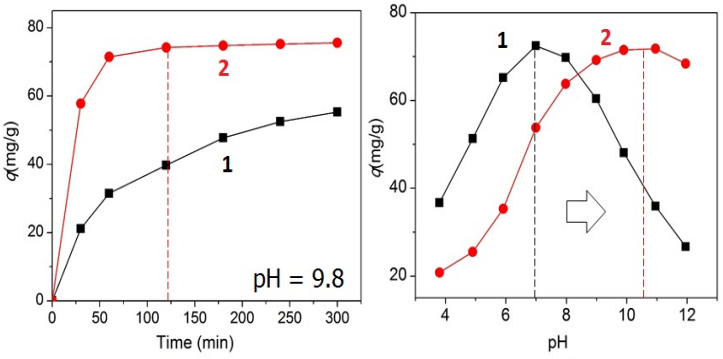


IR spectra



TGA spectra

Results and discussion



Time curves and pH effects on uranium adsorption

Cycle numbers	Sorption (mg g^{-1})	U(VI) recovery (%)
1	70.7	97.1
2	69.8	96.4
3	68.2	95.2
4	67.0	93.8
5	65.6	92.5
6	64.3	90.4

Sorption/desorption with 0.2 mol/L HNO_3 as a eluent.
$c(U(VI))_{initial}$ = 21.7 mg/L

Conclusions

- A U(VI) sorption magnetic material that work in alkaline media was developed by immobilizing ammonium phosphonate bi-functionalized groups on Fe_3O_4 nanoparticles.
- The combination of the bi-functionalized groups gave rise to an excellent ability to remove U(VI) with the maximum sorption capacity of 70.7 mg/g at pH 9.8.

Acknowledgement

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