New Progress of Chemistry of Actinides and Fission Products in Soochow University, China

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During the past three years, our group in Soochow University has deeply looked into two parallel research directions, both combining two fields of radiochemistry and metal-organic frameworks (MOFs). The first one is the synthesis and characterizations of actinide MOF compounds. This system is unique not only because compared to the transition metal and lanthanide systems, the actinide based MOFs are substantially less explored, but also that these compounds cannot be simply mimicked/predicted based on those analogues of transition metals and lanthanides owing to the uniqueness of actinide ions in bonding and coordination. In addition, we have found many interesting potential applications for these compounds including actinide waste form design for geological disposal, ion-exchange for remediation of radioactive contamination, and detection of extremely low-dose ionization radiations, further highlighting the bright future of adopting actinide ions in building of unique MOFs with potential applications in the nuclear industry.[1,2] The other research direction is the design and build of non-radioactive MOFs for rapid, efficient, and selective removal and detection of soluble radioisotope ions including UO_2^{2+}, Sr^{2+}, Cs^+, and TcO_4^- from aqueous solutions. Specifically, I will talk about three interesting examples within this direction: several single-crystalline zirconium phosphonate MOFs that are able to survive from fuming acids including aqua regia and can removal large amounts of uranium even from acidic solutions;[3] a luminescent mesoporous MOF equipped with abundant Lewis basic sites, which can be used for sequestration and detection of trace amounts of uranyl ion in the natural water systems including seawater;[4] the first experimental investigation of $^{99}TcO_4^-$ removal by a cationic MOF material showing many promises over the traditional anion-exchange materials.[5] These works clearly reveal that all the possible advantages for ideal radioisotope sorbent materials including high capacity, fast kinetics, excellent selectivity, and great stability and recyclability etc. can be indeed integrated in the MOF system.

REFERENCES

1. Y. Wang, Z. Liu, Y. Li, Z. Bai, W. Liu, Y. Wang, X. Xu, C. Xiao, D. Sheng, J. Diwu, J. Su, Z. Chai, T. E. Albrecht-Schmitt, and S. Wang, "Umbellate Distortions of the Uranyl Coordination Environment Result in a Stable and Porous Polycatenated Framework That Can Effectively Remove Cesium from Aqueous Solutions" J. Am. Chem. Soc., **137**, 6144-6147 (2015).
2. J. Xie, Y. Wang, W. Liu, X. Yin, L. Chen, Y. Zou, J. Diwu, Z. Chai, T. E. Albrecht-Schmitt, G. Liu, S. Wang, "Highly Sensitive Detection of Ionizing Radiations by a Photoluminescent Uranyl Organic Framework" Angew. Chem. Int. Ed., **56**, 7500-7504 (2017).
3. T. Zheng, Z. Yang, Z. Liu, D. Gui, X. Dai, S. Liu, L. Zhang, Y. Gao, L. Chen, D. Sheng, Y. Wang, J. Diwu, J. Wang, R. Zhou, Z. Chai, T. E. Albrecht-Schmitt, S. Wang, "Overcoming the Crystallization and Designability Issues in the Ultrastable Zirconium Phosphonate Framework System" Nat. Commun., **8**, 15369-15381 (2017).
4. W. Liu, X. Dai, Z. Bai, Y. Wang, Z. Yang, L. Zhang, L. Xu, L. Chen, Y. Li, D. Gui, J. Diwu, J. Wang, R. Zhou, Z. Chai, S. Wang, "Highly Sensitive and Selective Uranium Detection in Natural Water Systems Using a Luminescent Mesoporous Metal-Organic Framework Equipped with Abundant Lewis Basic Sites: A Combined Batch, X-ray Absorption Spectroscopy, and First Principle Simulation Investigation" Environ. Sci. Technol., **51**, 3911-3920 (2017).
5. D. Sheng, L. Zhu, Cha. Xu, C. Xiao, Y. Wang, Y. Wang, L. Chen, J. Diwu, J. Chen, Z. Chai, Thomas E. Albrecht-Schmitt, S. Wang, "Efficient and Selective Uptake of TcO_4^- by a Cationic Metal-Organic Framework Material with Open Ag^+ Sites" Environ. Sci. Technol., **51**, 3471-3479 (2017).