Development of MOF-type hybrid functionalized materials for selective uranium extraction

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Metal organic frameworks (MOFs) are hybrid crystalline materials consisting of an inorganic part (cluster or metal ions) and tailored organic linkers connected via coordination bonds. These materials have exceptional surface area, thermal stability and a large variety of tunable structures. They are used in different fields like catalysis,[1] metal adsorption,[2] gas separation[3] or photoluminescence.[4] However, due to the reversibility of constitutive coordination bonds, MOFs have moderate stability in strongly complexing or acidic media. Only few of them are known to be stable in aqueous media and only one example is described in strong acidic media.[5] However, these conditions are very often encountered in the environmental pollution remediation of mine wastewaters.

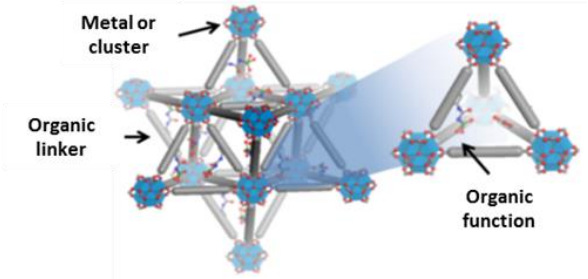

Figure 1. Artist view of UiO MOF structure functionalized with uranyl(VI) extracting motifs

To tackle the challenge of developing MOFs adapted for uranium extraction from acid mine waters, we have investigated the stability of several materials. The UiO family shows a great stability in sulfuric acid media even in the presence of 1.4 M sodium sulfate at pH 2. Consequently, we had developed a tertiary amine functionalized MOF adapted for the extraction of anionic uranyl(VI) sulfate complexes. The adsorption capacity of the material has been determined upon varying total sulfate concentration, contact time and uranium concentration. Finally, various spectroscopic technics were used for understanding uranyl(VI) extraction mechanisms and the interaction between uranyl and the MOF structure.

References

[1] J. Lee, O. K. Farha, J. Roberts, K. A. Scheidt, S. T. Nguyen, J. T. Hupp, *Chemical Society Reviews* **2009**, *38*, 1450-1459.

[2] M. Carboni, C. W. Abney, S. Liu, W. Lin, *Chem. Sci.* **2013**, *4*, 2396-2402.

[3] D. Banerjee, C. M. Simon, A. M. Plonka, R. K. Motkuri, J. Liu, X. Chen, B. Smit, J. B. Parise, M. Haranczyk, P. K. Thallapally, *Nat. Commun.* **2016**, *7*, ncomms11831.

[4] L. Li, J.-Y. Zou, S.-Y. You, H.-M. Cui, G.-P. Zeng, J.-Z. Cui, *Dalton Transactions* **2017**, *46*, 16432-16438.

[5] C.-Y. Gao, J. Ai, H.-R. Tian, D. Wu, Z.-M. Sun, *Chemical Communications* **2017**, *53*, 1293-1296.