

A New Class of Ion Exchange Materials: Polymer Threaded Metal Organic Framework with High Selectivity

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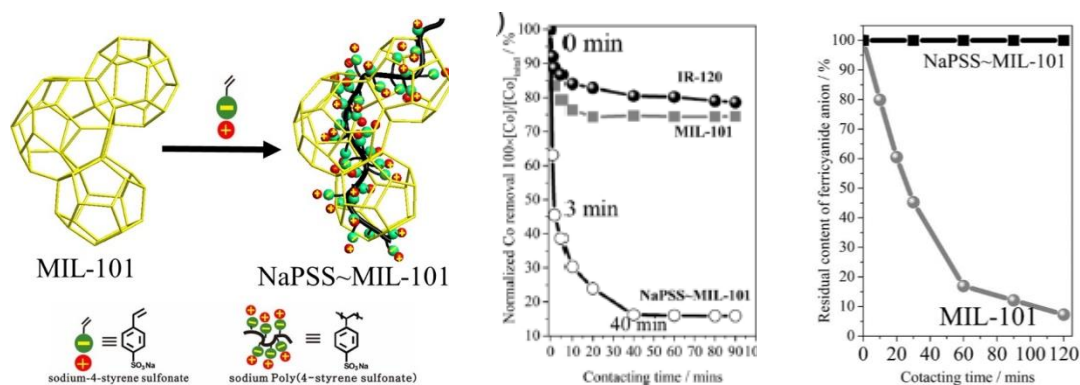
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The high porosity, high surface area and uniform ordered structure of metal organic frameworks (MOFs) have been explored in board applications. The unique characteristics of MOFs: high porosity, controlled swelling and high ion selectivity, align with the criteria of ideal ion exchange materials. Inspired by Kitigawa and co-workers [1], we extend the concept of “*in situ* polymerization in MOF” to include polymers functionalized to provide ion-exchangeable sites. [2-3] We report a porous metal–organic framework composite with flexible cation exchange polymers threaded within the host cavity.

The cation-exchange polymer~MOF composite, sodium-4-styrenesulfonate (NaPSS) threaded in MIL-101 (NaPSS~MIL-101), is synthesized by one-step *in situ* polymerization of sodium-4-styrenesulfonate monomer within the nanocavities of MIL-101Cr(III).[3] The synthesized non-cross-linked NaPSS~MIL-101 material demonstrates superior ion-exchange kinetics, high selectivity with co-ion rejection, reversibility, and enhanced durability over conventional ion-exchange resins. Due to the presence of the negatively charged sulfonate group inside MIL-101, only the cationic guest can enter NaPSS~MIL-101 and access to the anionic guest is denied. The open porous structure of MOF allows the physically trapped polymers to contact solvent freely and exchange ions efficiently, as oppose to the conventional ion-exchange resins in which the binding sites are hidden within the polymeric beads, preventing full utilization of ion exchange sites.



Schematic diagram of synthesis of NaPSS~MIL-101; The functionalized MIL-101 demonstrates superior Co(II) ion exchange over pristine MIL-101 and IR-120 (a conventional ion resin), and 100% anion rejection. [3]

[1] T.Uemura, K.Kitagawa, S. Horike, T. Kawamura, S. Kitagawa, M. Mizuno, and K. Endo, *Chem. Commun.* 48 (2005) 5968-70.

[2] L. Gao, C.Y. V. Li, K.Y. Chan, and Z.N. Chen, *J. Am. Chem. Soc.* 136 (2014) 7209-7212.

[3] L. Gao, C.Y. V. Li, K.Y. Chan, *Chem. Mater.* 27 (2015) 3601-3608.

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