Metal Ion-Imprinted Resins for Recovery of Metals from Seawater with a Novel Bifunctional Monomer by Surface Template Polymerization

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Summary

One of the promising approaches to create molecular-recognizing materials is "molecular imprinting" method. The new methodology does not require a precise molecular design and multi-step procedures to construct highly-selective polymers. In the technique, imprint molecules are bound to functional monomers in matrix-forming monomers. The monomers are then polymerized under the conditions that lead to a formation of a highly cross-linked matrix with chains in a fixed arrangement. Removal of the imprint molecules leaves behind cavities, whose sturucture and arrangement of the functional monomers are predetermined by the chemical nature of the template. We found that the interfacial activity of functional monomers is a dominant factor to succeed in preparing imprinted resins. It is also important to fix the recognition sites rigidly and to create high interactions between the functional monomers and imprint molecules.

In the present study we have designed 1,12-dodecanediol-O,O'-diphenyl phosphonic acid having two functional groups in the molecular structure as a recognition monomer, and prepared a highly-selective metal ion resin by surface template polymerization with a W/O emulsion. The separation of zinc and copper ions with the resins was conducted, and the template effect was characterized by comparing with that in ordinary solvent extraction for the metal ions. In the solvent extraction system an effective selectivity was not observed compared with that of the imprinted resins. Because the functional monomers (extractants) in the solvent extraction can take both the tetrahedral configuration for zinc ions and the planer configuration for copper ions due to the high mobility in the organic solvent, the selectivity to the ions only depends on the stability of the complex between the extractants and the ions. In contrast the functional monomers on Zn-imprinted resins are fixed in the tetrahedral configuration, therefore the ability in recognizing zinc ions is considered to be extremely high.

The imprinted resin exhibits a tremendously high selectivity between zinc and copper ions. It is concluded that the bifunctional monomer enables recognition sites to be rigid. Surface template polymerization will be to an ideal method to construct new molecular-recognizing materials for various water-soluble substances.