Separation of Heavy Metals by Selective Adsorption on Imprinted Thermosensitive Gels and Adsorption/Desorption properties by Temperature Swing

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Introduction: A novel gel adsorbent, which adsorbs and/or desorbs a specific heavy metal by the temperature swing, has been proposed. Thermosensitive gels swell in water at lower temperature, while shrink at higher temperature. The gel adsorbent has been prepared by copolymerizing N-isopropylacrylamide (NIPA) as thermosensitive component and chelating monomer, 4-(vinylbenzyl)ethylenediamine (Vb-EDA), by using imprinting technique. Figure 1 shows the schematic diagram of adsorption/desorption of Cu ion on/from the imprinted NIPA-co-(Vb-EDA) gel.

Experimental: NIPA-co-Vb-EDA gel imprinted with Cu(II) was synthesized by a radical polymerization in ethanol at 50 °C under the nitrogen atmosphere for 24 hours. The formed gel was washed with deionized water and 1M-HCl aqueous solution to remove residual monomers and copper ions, respectively. Finally the gel was dried, and was ground to powder.

Results and discussion: The amounts of the adsorption on the imprinted gel are plotted against temperature in Fig. 2 as well as those on NIPA gel prepared without chelating monomer. The adsorption amount on imprinted gel is very large compared with that on NIPA gel, and depends on temperature remarkably. The dependence leads to the adsorption/desorption control with temperature swing. The peak of the adsorption amount was observed at around 35 °C, in which the size of the gel in water corresponds to that prepared in ethanol. Figure 3 shows the results of the examination of selective adsorption of Cu ions as imprinted component. The measurements were carried out with the imprinted and non-imprinted gels. The imprinted gel adsorbent indicates the high selectivity. It is possibly due to the difference of coordination structure and ionic radius of Cu(II) and other metals. On the other hand, in the case of the non-imprinted gel, the adsorption amount of Cu was almost similar to that of Ni and Zn.