Enhancement of ion-exchange selectivity based on evaluation of ion-exchange equilibiria taking place in interfacial nanospace

Tetsuo Okada and Makoto Harada
Department of Chemistry, Tokyo Institute of Technology

Summary

In the present study, the local structures of cations in cation-exchange resins have been elucidated, and a novel zwitterionic molecule has been developed. These studies have aimed at gaining the molecular features involved in ion-exchange processes and developing separation with novel selectivity. The local structures of K^+ and Sr^{2+} in the cation-exchange resins have been studied by X-ray absorption fine structure (XAFS). The near edge structures of K^+ well reflect its peripherals, and thus some inferences are possible; (1) its local structure in the dried resin is apparently different from that of the hydrated ion; (2) the former structure is seen for the resin soaked in methanol but not detected for the resin soaked in water. The detailed analyses of XAFS spectra have revealed that (1) some of strontium ions in the resin are simultaneously bound by two sulfonate groups, but the fraction is very small (some %), (2) Sr^{2+} is more strongly hydrated even in the resin than K^+, and (3) 36±23 % of total K^+ and 17±7 % of Sr^{2+} form ion pairs with the sulfonate groups in the resin soaked in water, and the average hydration numbers are 4.0±1.1 and 4.8±0.3, respectively.

Our previous researches have indicated that zwitterionic ion-exchangers show very interesting features in ionic separation. A new zwitterionic molecule having two positive and on negative sites in a molecule (DE) has been synthesized. DE micelles are intrinsically cationic, and thus basically migrate toward the cathode in most of electrolytes. However, very interesting behavior has been verified that they migrate toward the anode in the presence of large amount of I^-. This strongly suggests that if this molecule is fixed on the solid matrix, it can be used both as a cation-exchanger and as an anion-exchanger. Although the ion-exchange properties of this molecule have been studied by the surface reflection XAFS, it has shown usual ion-exchange selectivity. Its specific features are worth studying in more details for the developments of ion-exchange materials with novel separation selectivity.