

Selective Adsorption of Ions by Porous Electrodes

Kenji Kiyohara¹, Yasushi Soneda², Akinari Sonoda¹, Yoji Makita¹

¹Health Research Institute, National Institute of Advanced Industrial Science and Technology

²Energy Technology Research Institute, National Institute of Advanced Industrial Science and Technology

Summary

Recovery of useful ions and removal of harmful ions from seawater are long standing problems. Recently, recovery of lithium ions from seawater and removal of radioactive cesium ions are among the most urgent ones of those kinds. To solve those problems, adsorption techniques using various porous materials have been applied. Those techniques, however, are expected to consume large amount of chemicals and generate large amount of waste in the long run, which are problematic from the viewpoint of protection of environment and resource.

As a technique to avoid such problems, we are examining the electrochemical one using porous electrodes for which the pore size is at the nanometer scale. When the pore size is as small as the ion diameter, the structure of the electrical double layer dramatically changes as functions of the ion diameter, the pore size, or the applied voltage. It has also been pointed out by theoretical studies that, for the case of multi-component electrolytes, the dominant ion species that composes the electrical double layer may vary depending on the pore size and the applied voltage. If this property of porous electrodes is applied to adsorption of ions, because the adsorption and desorption of ions due to the formation and extinction of the electrical double layer occur as a reversible process, consumption of chemicals and production of waste would be extremely suppressed compared to the conventional techniques.

In this work, we used a porous carbon material with the nanometer scale pore size as the electrode and examined its selective ion adsorption from aqueous electrolytes containing lithium, sodium, and cesium ions. Ion selective adsorption was observed and that was found to be functions of the concentration of the aqueous electrolytes and the applied voltage. The mechanism for the selective adsorption was discussed in terms of the molecular interaction.