

Functional-Graft-Chain-Containing Porous Sheets Designed for Clean-Up in Quantitative Analysis

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Summary

Minor components contained in solids such as foods and soils were dissolved in various acids for the determination of their contents. The clean-up procedure to exclude undesired components and concentrate a target analyte is essential for achieving a high accuracy of analysis. To do this, solid-phase extraction (SPE) techniques using a column charged with functional beads has been widely used; however, the time required for the SPE analysis is governed by the diffusion of target molecules or ions into the bead interior. To overcome this drawback, we prepared functional porous sheets for high-speed clean-up by radiation-induced graft polymerization and subsequent modifications. For example, a porous sheet capable of capturing heavy metal ions at a lower concentration level was prepared by a ring-opening reaction of the epoxy group of the poly-glycidyl methacrylate chain grafted onto a 2-mm-thick porous sheet, with an average pore size of 1 μm and a porosity of 70%, with a disodium iminodiacetate solution. The resultant chelating porous sheet containing an iminodiacetate group ($-\text{N}(\text{CH}_2(\text{COOH})_2)$), IDA sheet, had a chelate-forming group density of 2 mol/kg of the porous sheet and a pure water flux of 2 m/s at a permeation pressure of 0.1 MPa and 298 K. The IDA sheet was cut into disks 13 mm in diameter to fit a commercially available empty cylindrical cartridge. A CuCl_2 solution was permeated through the pores of the IDA sheet. Ideal adsorption characteristics of copper ions onto the IDA sheet were observed: the higher permeation rate of copper solution through the IDA sheet, the higher overall adsorption rate of copper ions onto the IDA sheet. This is due to the fact that the diffusion time of copper ions in the pore interior to the graft chain is much shorter than the residence time of the solution across the porous sheet. In addition, a nickel-ion-immobilized porous sheet was applicable to the purification of histidine (His)-tagged fusion proteins, which are useful molecules in various biotechnological studies. The preparation method suggested in this study is promising in that ligands based on various kinds of interaction such as ion-exchange, hydrophobic, and affinity interactions are appended onto the porous sheet at a controlled density.