Nanotek-2013

OMICS Group Conferences
Accelerating Scientific Discovery

3rd International Conference on
Nanotek & Expo

December 2-4, 2013 Las Vegas, USA

Functional polymer monoliths with nanoscale porous structure fabrication and applications

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Abstract

Monolith, a three-dimensional porous material having a continuous interconnected nanoscale pore structure in a single piece, has received much attention as functional materials such as chromatographic separation media, ion exchange resins, and catalyst supports due to its large air and liquid permeability, fast mass transfer performance, high stability and easy chemical modification. This study deals with fabrication of polymeric monoliths with nanoscale porous (mesoporous) structure by thermally induced phase separation (TIPS). Polyacrylonitrile (PAN) was insoluble in water but soluble in a mixture of water and DMSO at heating. A mesoporous monolith of PAN was fabricated by dissolution of the polymer in the mixture of solvents by heating, followed by phase separation on cooling. The formation of monolith depended on two factors: the concentration of the polymer and ratio of water/DMSO. A highly mesoporous N-doped activated carbon monolith was fabricated by carbonization and physical activation of the mesoporous PAN monolith in the presence of CO_2. The obtained monolith had high BET surface areas (>2500 m^2/g) and exhibited exceptionally high CO_2 uptake; 5.14 mmol/g at ambient pressure and temperature and 11.5 mmol/g at ambient pressure and 273 K. Furthermore, functional monoliths were prepared from reactive acrylic resins. A poly(methyl methacrylate-co-glycidiyl methacrylate) monolith was crosslinked by poly(ethylenimine) to the amine-containing monolith. Endotoxin, which must be removed from drug product containers as even small amounts, could be efficiently and selectively removed by this monolith from an aqueous solution containing endotoxin and globulin under the conditions of the fast elution.

Biography

He received his B.S. (1985) and M.S. (1987) from Kyoto University. In 1988, he joined the Department of Applied Chemistry, Tohoku University, as assistant professor and obtained Ph.D in 1991. He moved to the Department of Materials Chemistry, Kyoto University in 1997. In 2004, he was appointed as a full professor at the Department of Materials Chemistry, Osaka University. He has published more than 250 papers, 170 reviews and accounts, and 130 patents.