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Germania-Based, Sol-Gel Hybrid Organic-Inorganic Coatings for Capillary Microextraction and Gas Chromatography

Li Fang, Sameer Kulkarni, Khalid Alhooshani,* and Abdul Malik**

Department of Chemistry, University of South Florida, 4202 East Fowler Avenue, CHE 205, Tampa, Florida 33620-5250

Germania-based, sol-gel hybrid organic-inorganic coatings were developed for capillary microextraction and gas chromatography (GC). Being an isostructural analogue of SiO_2, GeO_2 is compatible with the silica network. Because of this similarity, germania-based materials possess great potential for being used in the areas of chromatographic separation and sample preparation. These possibilities, however, remain practically unexplored. To our knowledge, this is the first instance that a germania-based hybrid sol-gel material is used as a sorbent in analytical sample preparation or chromatographic separation. Tetramethoxygermane was used as a precursor to create a sol-gel network via hydrolytic polycondensation reactions performed within a fused-silica capillary. The growing sol-gel germania network was simultaneously reacted with an organic ligand that contained sol-gel-active sites in its chemical structure. Three different sol-gel-active ligands were used: (a) hydroxy-terminated poly(dimethylsiloxane), (b) hydroxy-terminated poly(dimethyldiphenylsiloxane), and (c) 3-aminopropyltrimethoxysilane. Solgel germania-coated capillaries of desired polarity and extraction selectivity were prepared by using an appropriately selected sol-gel-active ligand in the sol solution. These capillaries were further used to extract trace concentrations of polycyclic aromatic hydrocarbons, aldehydes, ketones, alcohols, phenols, and free fatty acids from aqueous samples. The extracted solutes were further analyzed by GC-FID. The new germania-based coatings showed excellent stability under harsh operation conditions involving extreme pH values, high temperatures, and aggressive solvents. Our preliminary results also indicate that sol-gel hybrid germania coatings have the potential to offer great analytical performance as GC stationary phases.

**To whom correspondence should be addressed. Phone: +1 813-974-9688. Fax: +1 813-974-3204. E-mail: malik@cas.usf.edu.

* Current affiliation: King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.