MEMBRANE ADSORBERS FOR RADIOCHEMICAL SEPARATIONS

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Traditional industrial radiochemical separation processes utilize techniques like liquid-liquid separation or resin based packed bed chromatography columns. However, these methods suffer limitations such as high effluent production, usage of large volumes of organic solvents, diffusion limitations and high pressure drop across packed columns. Particularly, in packed bed columns, the separation is dependent on the intra-particle diffusion of solute in the pores of the beads, which increases the process time, as diffusion is a slow process at small length scales. An interesting alternative to overcome the transport limitations experienced in packed columns is the use of modified microporous and/or macroporous membranes, known as membrane adsorbers. The primary mode of transport in membrane adsorbers is by convection, which allows for high throughput processing. Other advantages of membrane adsorbers include ease of scalability, lower pressure drops and lesser waste generation. Though membrane adsorption chromatography is a common method of rapid protein purification, the technology is not well studied for other separations. The aim of our research is to employ membrane adsorbers for unconventional applications including trace radioactive metal ion separation, environmental remediation by hazardous waste removal, medical isotope purification and trans-actinide separations.

Herein, we present phosphate-functionalized microfiltration membranes for two applications i) extraction of uranium from seawater ii) trans-actinide separation. Membranes of controllable capacities were prepared by grafting ethylene glycol methacrylate phosphate from the surface of polyethersulfone membranes by UV-initiated graft polymerization. The modified membranes were characterized by scanning electron microscopy to observe the change in surface morphology and fourier transform infrared spectroscopy to support the presence of functional groups. The binding affinity of the modified membranes have been estimated by performing equilibrium adsorption studies with individual metal ions. The performance of the membranes in dynamic binding mode has been studied. This work demonstrates the prospective of using affinity-based membrane adsorbers for trace metal ion removal and complex metal ion separation and illustrates a systematic approach for the development of the same.