

21st International Conference on

Advanced Materials & Nanotechnology

September 04-06, 2018 | Zürich, Switzerland

Functionalized track-etched PVDF membrane electrodes for heavy metal analysis in water

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Being a greatest earth's resource, water should be preserved. Its pollution effects on all living beings due to accumulation of toxic elements. Therefore, the needs of water quality monitoring are necessary to prevent potential contamination disasters. Currently, tolerable limits are in a few $\mu\text{g/L}$ that requires sensitive, environmentally friendly, fast and on site instruments, which are able to analyze heavy metal concentrations in water. To fit the requirements, we are developing a portable electrochemical device based on the functionalized membrane electrodes. These membrane electrodes are made of track-etched functionalized nanoporous poly (vinylidene fluoride) (PVDF) membranes of 9 μm thickness covered with gold layers of 35 nm thickness on each side. To create nanoporous membranes, PVDF films were irradiated by swift heavy ions. Chemical etching reveals ion tracks into nanopores. For sub-micron pore diameters, the reactivity of remaining radicals formed during irradiation was found sufficient to initiate free-radical polymerization of vinyl (or allyl) monomers. This method allows any selective polymer issued from radical polymerization to be grafted onto pore walls of PVDF membranes. For instance, poly (acrylic acid) has shown a high selectivity toward Pb^{2+} and Cu^{2+} ions, poly (4-vinylpyridine) toward Hg^{2+} . Recently developed bis [2-(methacryloyloxy) ethyl] phosphate (B2MP) grafted inside the nanopores of PVDF membranes were found efficient for pre-concentration of UO_2^{2+} from aqueous solutions. EPR, FESEM, FTIR were used to study radical content, morphology of the surface and presence of functional groups inside the nanopores. Voltammetry was used to demonstrate the sensitivity of such functionalized membrane electrodes in trace level. A first generation prototype exhibiting its own potentiostat, software and set of membrane electrode pads have been developed.

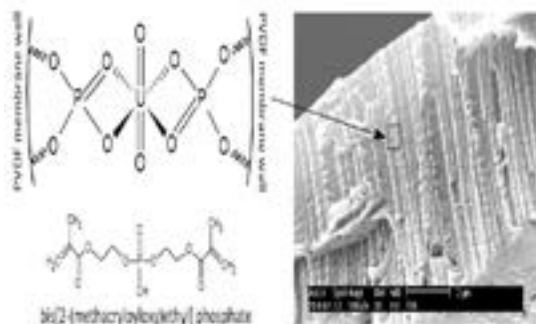


Figure: FESEM photo of cross section of B2MP functionalized track-etched PVDF membrane, fluence 10^9 cm^{-2} (right), and proposed configuration of UO_2^{2+} trapping by phosphate groups of B2MP (left)

Recent Publications

1. U Pinaeva, M C Clochard, E Balanzat, T L Wade, T C Dietz and M Al-Sheikhly Bis[2-(methacryloyloxy)ethyl] phosphate radiografted onto track-etched PVDF for uranium (VI) determination by means of cathodic stripping voltammetry Haz. Mat. 2018 (submitted) .

Biography

Uliana Pinaeva has completed her Master's degree in Applied Physics at the ENS de Cachan. Currently, she is pursuing her PhD in the Laboratoire des Solides Irradiés at the Ecole Polytechnique. Her research interest focuses on "Functionalization of polymers by means of radiation grafting technique for heavy-metal ions extraction and their following analysis by voltammetry".

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