Abstract

Workplace exposure to engineered nanoparticles (ENPs) is a potential health and environmental hazard. This paper reports a novel approach for tracking hazardous airborne ENPs by applying online poly (amic) acid membranes (PAA) with offline electrochemical detection. Test aerosol (Fe_2O_3, TiO_2 and ZnO) nanoparticles were produced using the Harvard (Versatile Engineered Generation System) VENGES system. The particle morphology, size and elemental composition were determined using SEM, XRD and EDS. The PAA membrane electrodes used to capture the airborne ENPs were either stand-alone or with electron-beam gold-coated paper substrates. Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were used to conceptually illustrate that exposure levels of industry-relevant classes of airborne nanoparticles could be captured and electrochemically detected at PAA membranes filter electrodes. CV parameters showed that PAA catalyzed the reduction of Fe_2O_3 to Fe^{2+} with a size-dependent shift in reduction potential (E^0). Using the proportionality of peak current to concentration, the amount of Fe_2O_3 was found to be 4.15×10^{-17} mol/cm^3 PAA electrodes. Using EIS, the maximum phase angle (Φ_{max}) and the interfacial charge transfer resistance (R_{ct}) increased significantly using 100 µg and 1000 µg of TiO_2 and ZnO respectively. The observed increase in Φ_{max} and R_{ct} at increasing concentration is consistent with the addition of an insulating layer of material on the electrode surface. The integrated VENGES/PAA filter sensor system has the potential to be used as a portable monitoring system.