593c Nanoarray Electrochemical Sensing for the Rapid Detection of Neurological Solutes

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Here, we present a simplistic, quick, and cheap fabrication method for a nanoarray electrochemical sensor that behaves like a single nanoelectrode in cyclic voltammetry. Our technique exploits the conical morphology of carbon nanopipettes, which taper from hundreds of nanometers (nm) in diameter at their bases to about 15 nm at the tips, a dimension that allows them to be utilized as nanoelectrodes. In addition, carbon nanopipette arrays are synthesized on platinum substrates that inherently serve as the electrical contacts in electrochemical measurements. Carbon nanopipettes are hollow carbon nanostructures with cores composed of a single/multi walled nanotube surrounded by an outer cone comprised of wrapped up sheets of graphite, which exposes graphite edge planes on their outer surface and yields high reversibility in electrochemical reactions. Achieving nanoelectrode behavior with nanopipettes requires their spatial distribution to be on the order of microns, thus preventing the overlapping of individual diffusion boundary layers. When the diffusion boundary layers overlap, the analyte undergoes slow, one-dimensional diffusion to the electrode surface. Fast, radial diffusion dominates when the boundary layers are independent of each other and do not overlap, which gives rise to nanoelectrode behavior. At their bases, carbon nanopipettes are very close to each other but their tips are well-spaced based on their tapered shape. Therefore, the simple application of an insulating coating, such as dip-coating in monomer solution followed by UV curing to form polymer, increases the spatial distribution of the carbon nanopipettes because only the well-spaced tips are exposed after the coating is applied. Nanoelectrode fabrication normally requires several steps of microfabrication that we have bypassed with our simple concept. As-synthesized carbon nanopipette arrays exhibit peak-shaped responses in cyclic voltammetry; whereas, polymer-coated nanoarrays yield sigmoidal responses and low background currents that are characteristic of nanoelectrode behavior at the scan rates employed. Nanoelectrodes are needed to accomplish the sensing of neurological solutes at high scan rates over very short time scales (milliseconds). Studies on the performance of our nanoarray sensor are underway for the simultaneous detection of multiple compounds, determination of fouling resistance, and *in vitro* detection of neurotransmitters.