Sacrificial dye electrode for non-gassing electro-osmotic pumps

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Electro-osmotic pumps (EOPs) are the arguably simplest of all known micro pumps merely consist of porous silica membrane sandwiched between two electrodes. They generate significant flow rate and pressure by electroosmosis through silica membrane. The traditional EOPs limited to only platinum electrode and porous silica frits, which have the disadvantage of generating oxygen at anode and hydrogen at the cathode by electrolysis of water on platinum electrodes. The generated gas bubbles adhere to electrode and membranes surfaces and blocks steady flow of the pump. The first non-gassing EOP was reported in 1977 by Luft, Kuehl, and Richter [1]. Guzman et al. reported low-voltage gel electrophoresis of large polyanions in microchannels with rechargeable Ag/AgCl electrodes and 40-100 mM NaCl solutions,[2] showing that electrolysis, resulting in gassing, can be avoided in electrophoretic systems. Very recently [3], we have reported the highly efficient non-gassing but consumable Ag/Ag2O electrodes for EOP applications.

Here we are reporting the consumable dye, alizarin based electrode material for the non-gassing EOPs. Alizarin is a derivative of anthraquinone, with hydroxyl groups substituted at the 1 and 2 positions. The consumable flow-through electrodes were prepared by dip coating carbon paper with paste consisting of alizarin, TimCal graphitic carbon and Nafion solution with weight ratio 3:1:1 respectively in isopropanol. Figure 1 shows the cyclic voltammogram of the paste drop coated on the glassy carbon electrode in oxygen and nitrogen atmosphere.

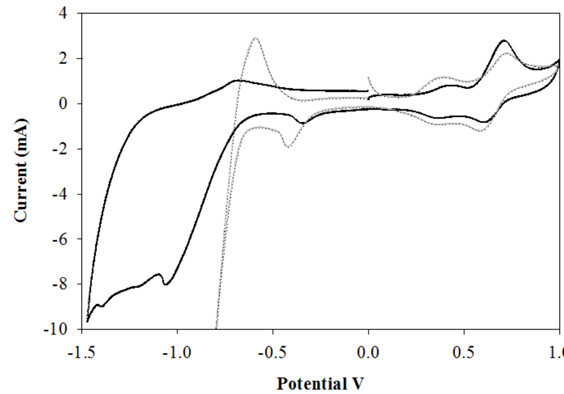

Figure 1. Cyclic voltammogram of the alizarin paste drop coated on glassy carbon electrode as working, Ag/AgCl as reference and Pt wire as counter electrode. 100mM KNO_3 as electrolyte. Scan rate 10mV/s.

The EOP was assembled as reported [3] and their performance was evaluated at constant potential (figure 2).

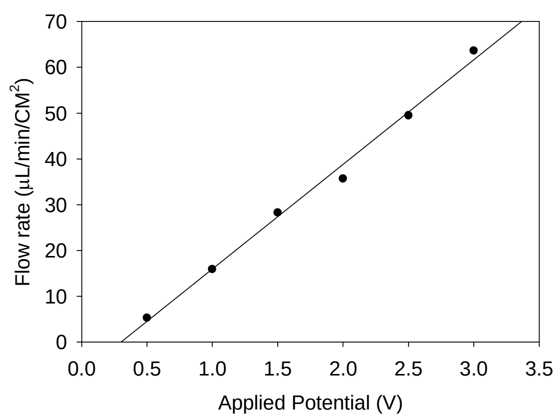

Figure 2. Dependence of flow rate versus applied potential.

At 1V constant potential we could observe the 18µL/min/cm^2 flow of water. The flow rate was constant for ~10h or till the consumption of electro active alizarin when run continuously.

References:

1. Luft, G.; Kuehl, D.; Richter, G. *J. Biomed. Tech*. **1977**, *22*, 169.
2. Guzman, K. A. D.; Karnik, R. N.; Newman, J. S.; Majumdar, A. *J. Microelectromech. Syst*. **2006**, *15*, 237.
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