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ELECTROCHEMICAL BEHAVIOR OF POLYPYRROLE SOFT ACTUATOR IN LiCl AND $BaCl_2$ AQUEOUS ELECTROLYTES

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Inherently conducting polymers (ICPs) are functional materials featuring significant physical properties. Among a large number of ICPs, some of them exhibit a change in volume considerably when their redox state is altered in aqueous electrolytes. This property is exploited for the use as artificial muscles or soft actuators. This change in volume in ICPs is caused due to insertion or expulsion of hydrated counter ion transport, along with osmosis water movement. The present work aims to explore the osmosis water transport into ICPs during redox cycling process and focused on polypyrrole, doped with the immobile anion dodecyl benzene sulfonate (PPy/DBS), because it has been identified as a good candidate for the use as artificial muscles. For this study, PPy/DBS films of thickness 400 nm were electropolymerized on 6 MHz AT-cut quartz crystal electrodes from synthesize solution containing 0.05M pyrrole monomer in 0.05M NaDBS solution and characterized by simultaneous cyclic voltammetry and Electrochemical Quartz Crystal Microbalance measurements. The PPy/DBS films were cycled in 0.1M LiCl, 2M LiCl, 0.1M $BaCl_2$ and 1M $BaCl_2$ electrolytes. The cyclic voltammograms of the films contained a sharp reduction peak due to insertion of cations and two oxidation peaks, representing expulsion of cations and then insertion of anions. It was found that the osmosis water transport in LiCl electrolytes occurs soon after the insertion of hydrated Li^+ during the cathodic reduction of these films whereas it is being during the subsequent oxidation of the film in $BaCl_2$ electrolytes, during insertion of Cl^-. Furthermore, when comparing with high and low concentrations in both electrolytes, a larger frequency change was obtained in low concentrations rather than in higher concentrations, indicating that the osmosis effect is larger in thin concentrations. This study shows that the osmosis water transport into PPy/DBS soft actuators strongly depends on the cation type presence in the cycling electrolyte.

Keywords: *Polypyrrole, Osmosis Water Transport, EQCM, Soft Actuator*