Disposable Miniaturized Screen-Printed pH and Reference Electrodes for Potentiometric Systems

This work describes the development of a miniaturized potentiometric system comprising a miniaturized quasi-reference electrode (QRE) coupled to a solid-state ion-selective electrode (ISE) for the monitoring of pH. We describe the optimization of materials and fabrication processes including screen-printing (SP), electrode treatments (thermal and electrochemical) and the formulation and deposition of an ion-selective membrane (ISM), to obtain a system compliant with biomedical specifications. We developed a potentiometric system composed of an Ag/AgCl QRE and a pH-electrode (ISM deposited on a graphite electrode) that can be used continuously for a period of not less than 7 days in aqueous solutions. Curing the Ag/AgCl pastes during 20 minutes at 120 °C after printing allowed the QREs to display excellent potential stability, as demonstrated by an open-circuit-potential standard deviation of ±1.2 mV over a period of 7 days (n=3 samples). Promoting adhesion of the pH membrane over graphite electrodes improved the pH-electrode performance. This was achieved through a combination of thermal treatment and electrochemical activation of the electrodes by cyclic voltammetry (CV). The final device integrated both the QRE and the pH-electrode, and displayed an average pH sensitivity of −60.8±1.7 mV per pH unit, over a pH range of 7.00 to 7.63.

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