Go Mini or Go Home! Fabrication and Evaluation of Miniature Solid-State Ion-Selective Electrodes for pH Measurement

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pH sensors have long been utilized and studied given their importance to everyday processes, especially food production. Inaccurate pH sensing has severe repercussions, such as potential botulism (fatal illness) from eating improperly-canned low-acid foods. Currently, the pH glass electrode is most used, favored for its higher accuracy than universal indicators, and simplicity compared to spectrophotometers. However, its main drawback is bulkiness, as it is tough to reduce electrolyte volume to below milliliter levels. Given the rising 21st Century demand for miniature devices, and operational advantages like shorter signal paths, solid-state ion-selective electrodes (SS-ISEs) are an ideal alternative. This work aims to fabricate miniature pH SS-ISEs and evaluate its performance against conventional ISEs in terms of sensitivity, stability and reproducibility. Microelectromechanical systems fabrication was performed - chips were sonicated and plasma cleaned, then wire bonded to a printed circuit board. Wires were passivated with epoxy to enhance durability. Polyaniline was deposited as the pH-sensitive coating via cyclic voltammetry. Subsequently, SS-ISEs underwent a complete cycle of testing in buffers between pH3 and pH10, for sensitivity and reproducibility. For stability, SS-ISEs were incubated at 55°C to simulate an 80-day window, and tested on Days 0 and 10 for potential drifting. Results indicate successful miniaturization, with electrodes measuring 3mm by 6mm. Compared to conventional ISEs, SS-ISEs display higher reproducibility and stability, and excellent sensitivity within the ideal commercial range. Future work could involve exploring alternative polymer coatings to improve flexibility and stretchability, for affordable non-invasive wearable health sensors.

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