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Micrometer-thick and porous nanocomposite coating for electrochemical sensors with exceptional antifouling and electroconducting properties

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Abstract

Development of coating technologies for electrochemical sensors that consistently exhibit antifouling activities in diverse and complex biological environments over extended time is vital for effective medical devices and diagnostics. Here, we describe a micrometer-thick, porous nanocomposite coating with both antifouling and electroconducting properties that enhances the sensitivity of electrochemical sensors. Nozzle printing of oil-in-water emulsion is used to create a 1 micrometer thick coating composed of cross-linked albumin with interconnected pores and gold nanowires. The layer resists biofouling and maintains rapid electron transfer kinetics for over one month when exposed directly to complex biological fluids, including serum and nasopharyngeal secretions. Compared to a thinner (nanometer thick) antifouling coating made with drop casting or a spin coating of the same thickness, the thick porous nanocomposite sensor exhibits sensitivities that are enhanced by 3.75- to 17-fold when three different target biomolecules are tested. As a result, emulsion-coated, multiplexed electrochemical sensors can carry out simultaneous detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) nucleic acid, antigen, and host antibody in clinical specimens with high sensitivity and specificity. This thick porous emulsion coating technology holds promise in addressing hurdles currently restricting the application of electrochemical sensors for point-of-care diagnostics, implantable devices, and other healthcare monitoring systems.

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