DNA-origami derived nanoplatelet bioactive surface for detection of sexually transmitted infections (STIs)

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Abstract: Sexually transmitted infections (STIs) are among the most common communicable diseases globally and are associated with significant morbidity and mortality worldwide. Rapid, low-cost, point-of-care (POC) assays based on nucleic acid testing have the potential to revolutionize the prevention and control of STIs. By facilitating early-detection, species-specific diagnoses, these assays can expedite treatment initiation, thereby mitigating transmission and curtailing the complications associated with untreated infections. A crucial step in developing assays for early STI pathogen detection is identifying reliable sensing probes that can selectively and sensitively detect specific genetic targets within these pathogens. Spatially reconfigurable DNA origami nanostructures are excellent candidates for the generation of custom sensing probes. DNA origami technology can create specific nanostructure shapes in both two and three dimensions and also precisely arrange molecules with varied functionalities. The functionalization of DNA origami nanostructure endows the sensing system potential of filling in weak spots in traditional DNA-based POC assays. Here we present a nanoscale POC electrochemical biosensing assay that combines the accuracy and precision of the DNA origami nanofabrication technique with the unique electrochemical responses of the DNA-origami-derived nanoplatelet bioactive surface, and the high affinity and selectivity of the single-stranded oligonucleotides(ss-ODNs). This combination enables selective and sensitive detection of targets even in strongly absorbing fluids. As a model approach, we have demonstrated the applicability of the DNA origami-derived nanoplatelet bioactive surface for the selective and sensitive electrochemical based detection of three different target genes (tp47, polA, and tprE) of *T. pallidum*, the causative agent of syphilis. We anticipate that the sensing scheme presented can be adapted for detecting a wide range of pathogens in various analytical fluids and tailored to specific needs.