Aerosol Jet Printing Enabled Dual-Function Electrochemical and Colorimetric Biosensor for SARS-CoV-2 Detection

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Infectious diseases have been a continuous threat to human beings. The coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has led to a pandemic still ongoing worldwide. High selectivity and reliability is of vital importance for acute SARS-CoV-2 detection. In this work, a robust dual-function electrochemical and colorimetric sensing platform using graphene electrodes for the detection of acute SARS-CoV-2 is developed with a high sensitivity, selectivity, acceptable rapidity, and excellent extensibility. We report a viral detection strategy based on the clustered regularly interspaced short palindromic repeats (CRISPR)/Cas13 system (Figure 1a). In this method, the viral RNA is directly recognized by CRISPR/Cas13 complex, leading to the nonspecific cleavage of the ssRNA reporters. Anti-FAM horseradish peroxidase (HRP) is then bound to the ssRNA reporter and isolated by magnetic beads, inducing a color change through the oxidation of 3,3′,5,5′- tetramethylbenzidine (TMB). The joint effects of the high catalytic activity of HRP-mimicking DNAzyme toward TMB substrate

reduction and the excellent competing reaction contributed to the great enhancement of the sensitivity. Such a dual mode sensing strategy allows for ultrasensitive acute SARS-CoV-2 with a detection limit as low as 200 fM. This electrochemical and colorimetric approach holds great promise as a new point-of-care diagnostic tool for the early detection of SARS-CoV-2 virus and many types of infectious diseases.

Our sensor is fabricated using a 3-D aerosol jet printing technology (Figure 1b). The aerosol jet process uses aerodynamic focusing to deposit inks precisely onto the substrates, The photonic curing makes the inkjet chip quickly molded with high stability and sensitivity. The material cost per electrode is ~$0.003, which is much cheaper than the commercially produced electrodes. Therefore, this inexpensive and adaptable biosensor is ideal for the detection of for viral infections in point-of-care settings.

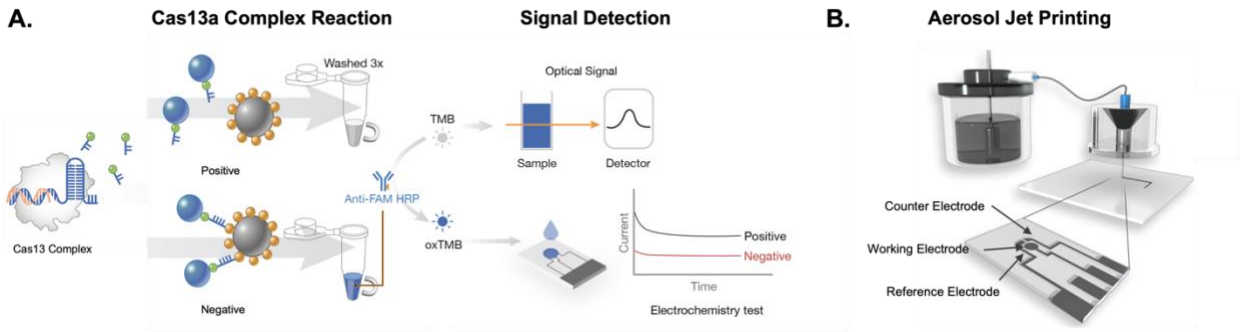

Figure 1. A. Schematic of the whole reaction strategy and signal detection method. B. Schematic of the aerosol jet printing process and an image of the graphene electrode with the working electrode, counter electrode, and reference electrode.