Development of a Polydiacetylene-Based Paper Biosensor for Naked-Eye Detection of COVID-19 in Saliva

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Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus that has been declared a global pandemic since March 2020. Reverse transcription polymerase chain reaction (RT-PCR) is one of the most commonly used methods for diagnosing COVID-19 due to its high accuracy, although it can take several hours to return results and is very expensive to administer. Furthermore, this type of test cannot be administered in home environments or developing regions of the world where patients do not have training in necessary techniques (collecting, handling, and processing samples) or access to proper medical equipment. In this paper, a polydiacetylene-based paper biosensor for detection of the COVID-19 spike protein in saliva was developed, with a blue-to-red colorimetric output when exposed to the target protein. The concentration of the N-Hydroxysuccinimide ester of 10, 12-pentacosadiynoic acid (PCDA-NHS) in the polydiacetylene polymer was manipulated to optimize the sensor's colorimetric response. An optimal PCDA-NHS molar concentration was determined to be 10%. With naked-eye readout, qualitative observations of the sensing platform were able to determine COVID-19 spike protein presence with a limit of detection of 1 ng/mL after four hours of incubation in salivary solutions. Smartphone images of the sensors after exposure to the spike protein were used to quantify the red chromatic shift (RCS) of the sensor response. These results indicate the potential use of this sensor in developing regions of the world, as well as home environments, due to the low cost, high sensitivity, and user-friendly design of the sensing device.

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