Virtual Research Presentation Conference

A novel rapid turnaround test for detecting SARS-CoV-2

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Program: Spontaneous Concept

Assigned Presentation # RPC-139

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Tutorial Introduction

Abstract

The lack of a large population testing capacity for the current SARS-CoV-2 global public health crisis highlights the critical need for rapid, low cost, and mass-producible diagnostics. Specifically, the current standard testing protocol, real-time quantitative polymerase chain reaction (rt-qPCR), has an inherently long time-to-diagnosis due to inadequate supplies, limited trained personnel, and extended sample processing time. The proposed proof-of-concept platforms analyzed in this study use lateral flow assays, the same fundamental technology used in pregnancy tests, for a visual colorimetric detection that targets SARS-CoV-2 genomic material at a high specificity. A positive test result is indicated by a pink line appearing on the test site, and proper sample flow was indicated by an additional control line further down the paper strip. The results from this study demonstrates a surface nucleic acid-based sensing platform that is capable of targeting SARS-CoV-2 genomic material with time to result in under 15 minutes and may be mass-produced on the order of dollars or less. With further optimization, the sensor may be used a rapid diagnostic tool to accompany current clinical procedures or as a stand-alone test following viral sample processing.

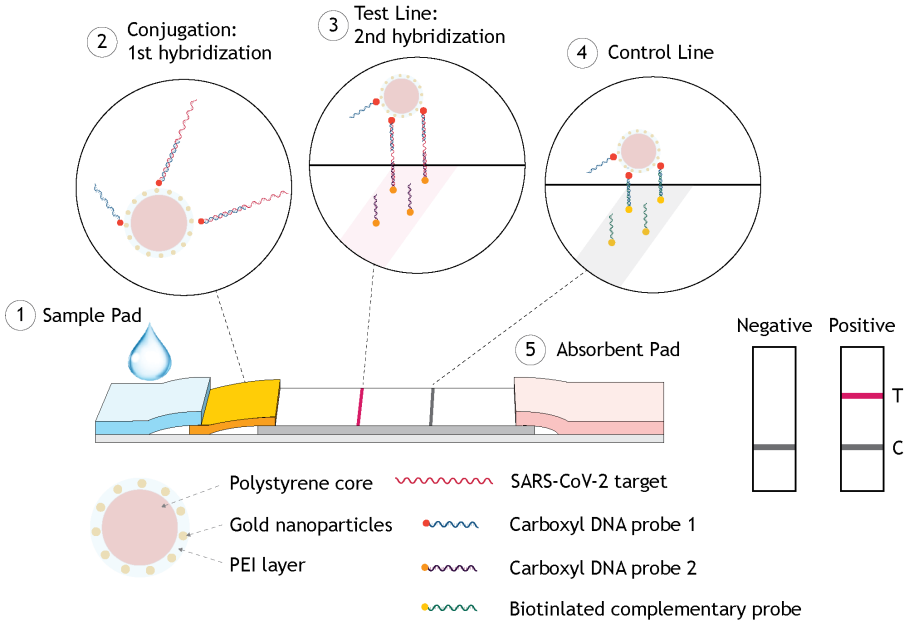


Figure 1. Schematic illustration of the lateral flow biosensor for identification of SARS-CoV-2 (Covid19).

CONTEXT

The lack of a large population testing capacity for the current SARS-CoV-2 global public health crisis highlights the critical need for rapid, low cost, and mass-producible diagnostics.

CURRENT STANDARDS

Real-time quantitative polymerase chain reaction (RT-qPCR), has an inherently long time-to-diagnosis due to inadequate supplies, limited trained personnel, and extended sample processing time.

RELEVANCE

The fundamental technology is applicable to life detection and habitability initiatives, as well as human spaceflight to identify water contaminates, disinfection products, and relevant microorganisms.

Methodology

OBJECTIVE

Fundamentally understand the molecular interactions that would result in the successful proof-of-concept demonstration of a surface nucleic acid-based sensing platform aimed at the rapid, sensitive and selective detection of the SARS-CoV-2.

METHODS

Label Materials Characterization → Particle Stability Measurements → Sensor Assembly → Sensor Results → Optimization and User Experience

DELIVERABLES

01
Ensure label particles are properly synthesized

02
Label particle lifetime optimization

03
Membrane selection, proper inkjet printing, and sensor assembly

04
Preliminary sensor results demonstrating feasibility of SARS-CoV-2 LFA

05
Identify roadmap to optimization and prototype sensor case

Results

Label Materials Characterization

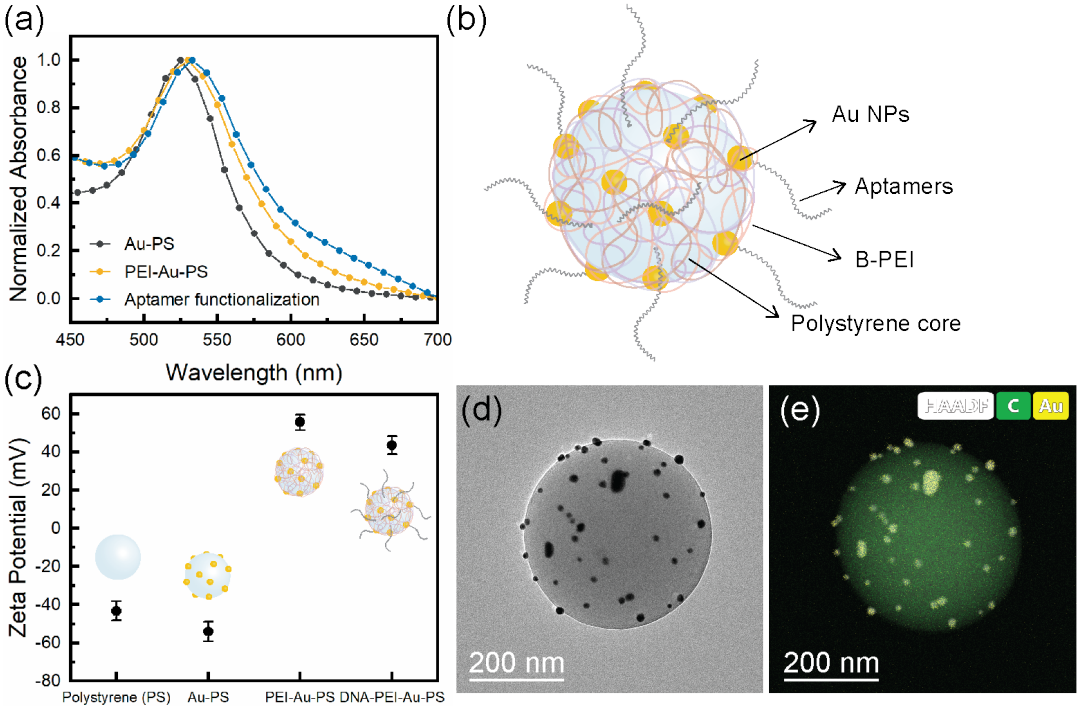


Figure 2. (a) Normalized UV-Vis adsorption spectra of gold decorated polystyrene (Au-PS), PEI-Au-PS, and functionalized ssDNA-PEI-Au-PS complex. (b) Graphic illustration of the self-assembled materials used to fabricate PEI encapsulated label particles. (c) Zeta potential distributions during surface modifications. (d) Bright-field TEM image and (e) High-angle annual dark-field STEM mapping, with C and Au elements, from as-prepared Au-PS particles.

Results

Particle Stability Measurements using UV-Vis

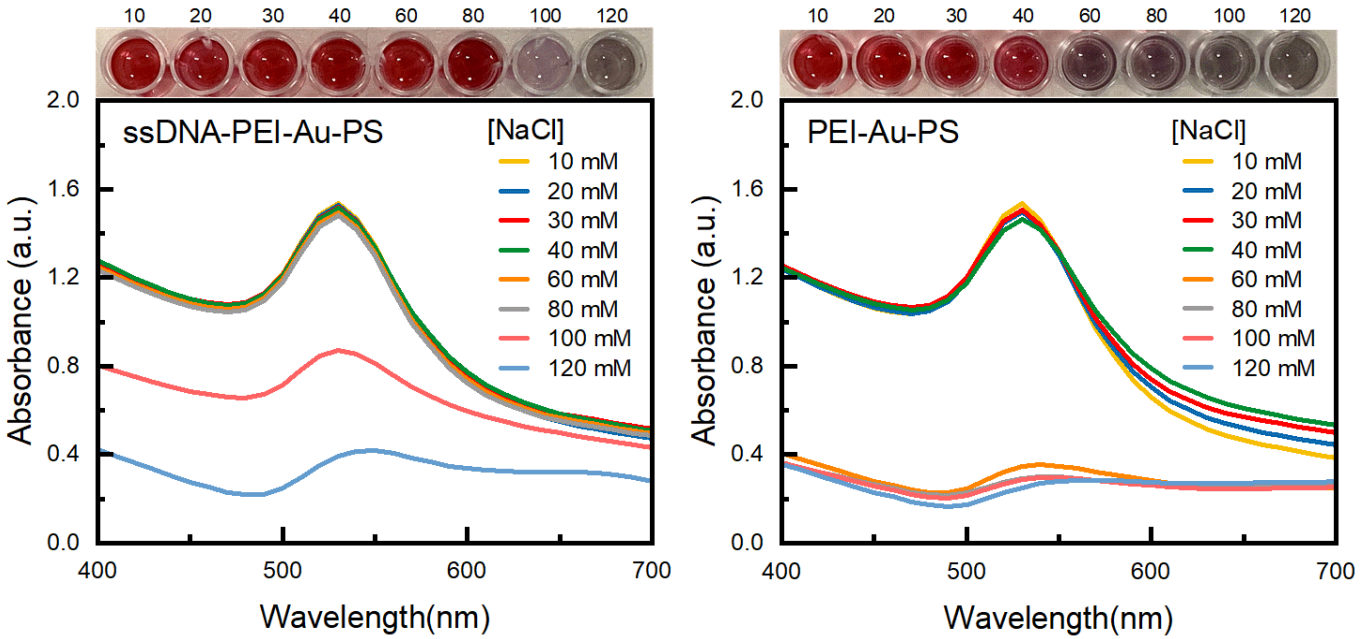


Figure 3. Stability evaluation of PEI-Au-Ps, and functionalized ssDNA-PEI-Au-Ps complex.

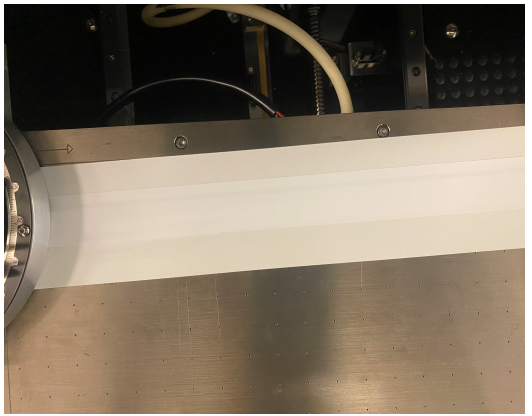
Results

Sensor Assembly

Membrane	Capillary Flow Time Specification** (sec/4 cm)	Flow Rate	Sensitivity
HF180	180 ± 45	Slowest	Most sensitive
HF135	135 ± 34	↓	↓
HF120	120 ± 30		
HF090	90 ± 23		
HF075	75 ± 19	Fastest	Least sensitive

Figure 4. Summary of membrane optimization results.

Successful inkjet-printed DNA on the test/control lines



Results

Sensor Results

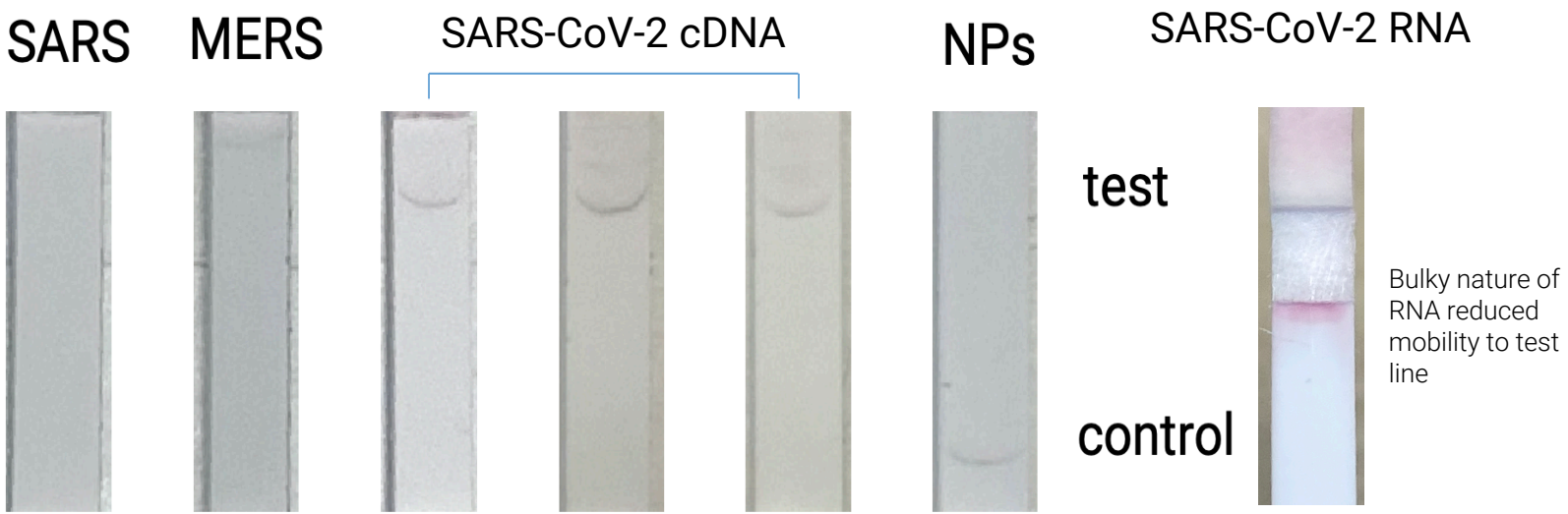


Figure 5. (From left to right) Results from SARS, MERS, SARS-CoV-2 cDNA, negative control, and SARS-CoV-2 RNA lateral flow assays.

Significance and Next Steps

Time to result in under 15 minutes

Cost per test on order of dollars or less when mass produced

Optimize proper sample flow of RNA, streamline processing, and increase sensitivity

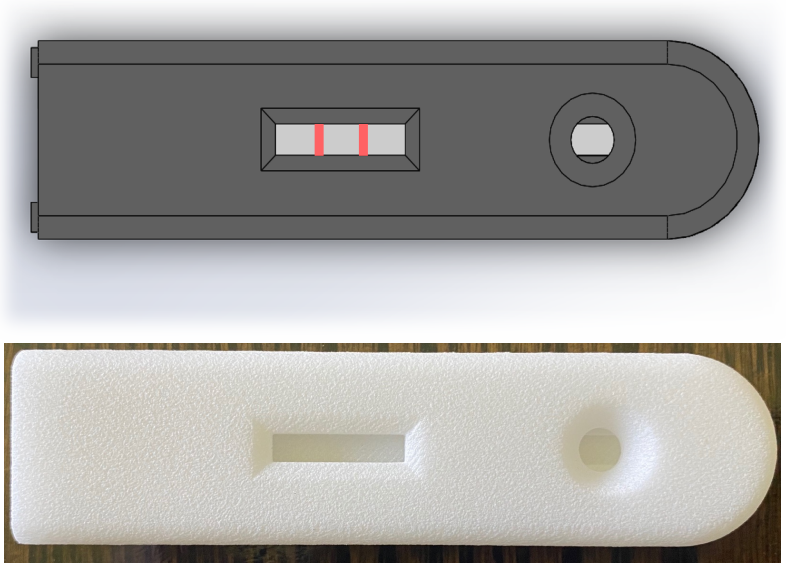


Figure 6. CAD rendering (top) and initial prototype (bottom) of sensor enclosure.

References

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