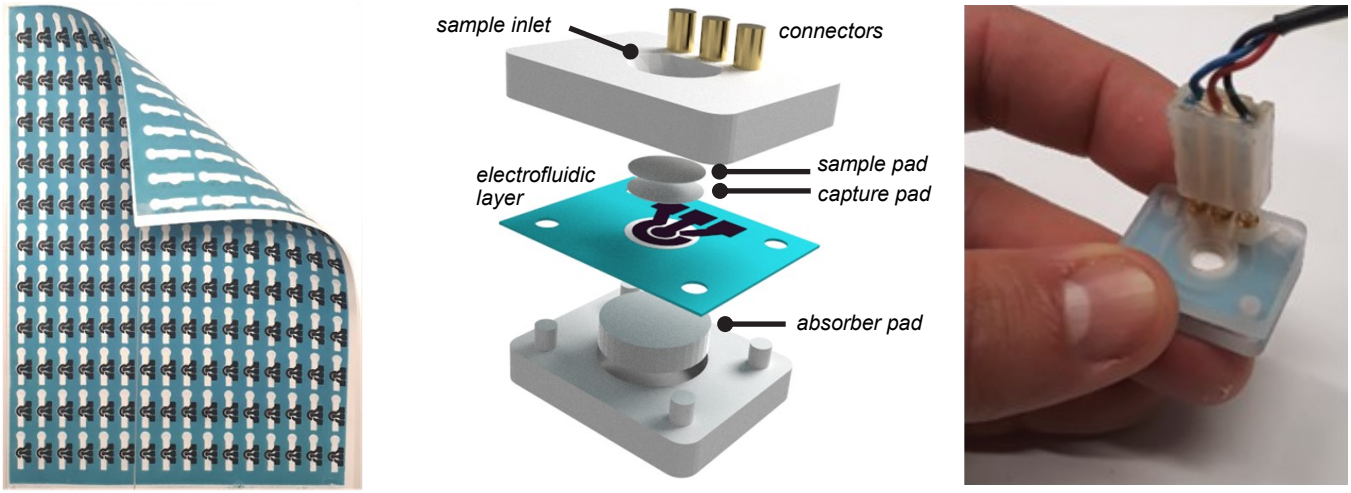
ETH zürich

Licensing Opportunity

Paper-based electrodes for more accurate rapid tests



(left) DIN-A4 cellulose paper with graphenic electrodes and wax microfluidic channels, (middle) schematic assembly of a rapid diagnostic test, (right) implementation of an electrochemical Covid-19 antibody test.

Application

This rapid diagnostic test kit combines the convenience of a fluidic assay with the reliability of an electrochemical readout within the same unit. Applications lie in the field of clinical diagnostics, chemical analysis, food inspection and environmental monitoring.

Features & Benefits

- high sensitivity with the entire sample flowing *through* the electrode
- easily interpretable, digital signal outputs
- low-cost, single-use electrodes
- scalable, rapidly adaptable fabrication process

Publications

- "Paper-Based Laser-Pyrolyzed Electrofluidics: An Electrochemical Platform for Capillary-Driven Diagnostic Bioassays", Adv. Mater. 2023, 2302893 https://dx.doi.org/10.1002/adma.202302893
- Patent pending

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Technology Readiness Level

1 2 3 **4** 5 6 7 8 9

Background

Rapid diagnostic tests are indispensable tools for disease diagnosis at the point of care. These low-cost devices utilize the capillarity of paper to passively drive the assay, thus minimizing user operations. However, the colorimetric readout of these tests is limiting; the results are often qualitative, rather than quantitative, and prone to human bias during interpretation. Electrochemical signal transduction circumvents this issue by enabling easily-interpretable, quantitative digital signal outputs.

Invention

A commercial CO_2 laser engraves electrodes directly into paper. This approach utilizes cellulose not only as a substrate but also as the precursor for creating electrodes. The laser parameters have been optimized to create graphenic structures whilst maintaining structural integrity. The resulting electrodes display high conductivity, a porous electroactive structure and, remarkably, retain the capillary properties of natural cellulose paper. In short, permeable electronic functionalities can be seamlessly integrated into cellulose paper with no detrimental effects on the structural or wetting characteristics. Combined with wax patterning of fluidic channels clinically-relevant digitalized rapid diagnostic tests, such as the Covid-19 antibody tests, were fabricated and successfully tested.

The fabrication process is low cost, scalable, and does not rely on toxic chemicals or specialized equipment. The two essential processes – CO_2 laser engraving and wax lamination – are both compatible with roll-to-roll processing.