

# NextGenMicrofluidics: low-cost. modular Lab-on-a-Cartridge devices for public health and food safety monitoring

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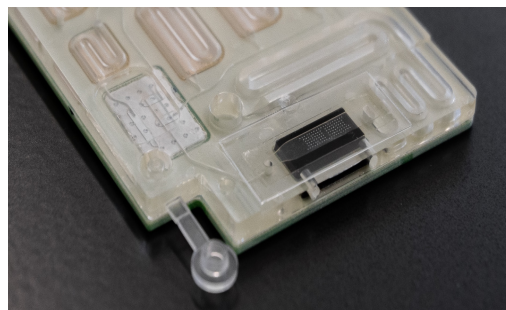
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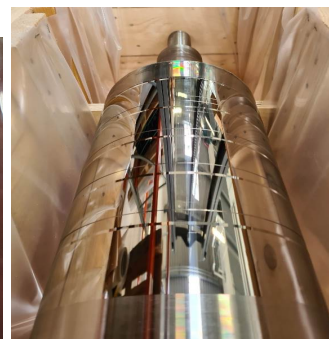
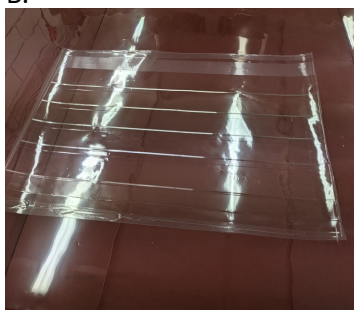
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Current and emerging challenges to public health and food safety, due to infectious disease outbreaks, new toxins and rising antibiotic resistance, coupled with environmental change and shifting consumer habits and preferences have stressed the need for low-cost and reliable diagnostic tests that can be widely-implemented at the Point-of-Need or Point-of-Care. In an attempt to address this demand, and within the context of the H2020 NextGenMicrofluidics project, we have focused on the development of portable devices that combine microfluidics-based cartridges made by injection-molding with structured sensor foils produced on a large scale and cost-efficiently by roll-to-roll (R2R) procedures. The modular design of the cartridges, consisting of reaction chambers and reservoirs carefully-selected from a design library allows for a plethora of biochemical and molecular assays to be undertaken, while detection multiplexity is achieved through the utilization of probe microarrays, spotted onto appropriately-functionalized polymer sensor foils. The latter also serves as a waveguiding element, where a sensitive TIRF (total internal reflection fluorescence) readout is realized. Furthermore, liquids are moved within the cartridge by integrated electrochemical micropump, making PCB-based fluidic actuation obsolete. To showcase the capabilities of these devices, the multiplexed detection of the genetic material of SARS-CoV-2 as well as Influenza A (both H1N1 and H3N2 strains) is demonstrated, while for food safety, the combined detection of antibiotics and Aflatoxin M1 in milk with the use of aptamers acts as the target application. The elegant combination of the aforementioned advances and innovations in assay development, sensor foil fabrication and biofunctionalization, cartridge design and fluidics actuation act as a paradigm shift in the development of portable biosensing platforms and will significantly aid towards both disease management in the general population as well as safeguarding food safety and quality in the challenging times to come.

A.



B.



**Figure 1:** A) Prototype cartridge with probe-spotted sensor foil, B) Structured sensor foil with in-coupling and out-coupling optical structures for TIRF-based detection (left) and the roller used to fabricated the master shim for sensor foil fabrication by R2R Extrusion-coating (right).