Next Generation of Microfluidics for safe and sustainable diagnostics devices

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Microfluidic devices

Biological assays have been shifting towards **miniaturization** increasing lab work efficiency and enabling high-throughput. **Microfluidics** have shown intrinsic ability to manipulate very small volumes of fluids in a variety of integrated ways including sample processing, accurate control of fluids and delivery of results with a fast time. Huge potential of **advanced automated point-of-care (POC) systems is expected.**

Next Generation Microfluidics OITB

The founded association Microfluidics Innovation Hub (MIH) of the **NextGenMicrofluidics OITB** offers customers a **single-entry point service catalog** to a wide range of existing cutting-edge microfluidic technologies **to accelerate** the demonstration of scientific breakthroughs towards a working prototype and beyond into mass manufacturing. Here, we present preliminary results of the **Safety & Sustainability assessment of next generation microfluidic devices for diagnostics applications**.

Figure 1. Value Chain of the MIH

Accelerating the manufacturing process

The **translation of lab scale devices to Industry** (and clinical studies) requires a large number of integrated microfluidic devices, being relevant the high-volume manufacturing methods for upscaling of such microfluidic devices**. Roll-to-roll (R2R) imprinting** enables parallel and high-throughput generation of micro or even nanostructures in various designs due to a production performed on flexible polymer foil and the possibility of post-processing step such as bio-functionalization, chip lamination and others.

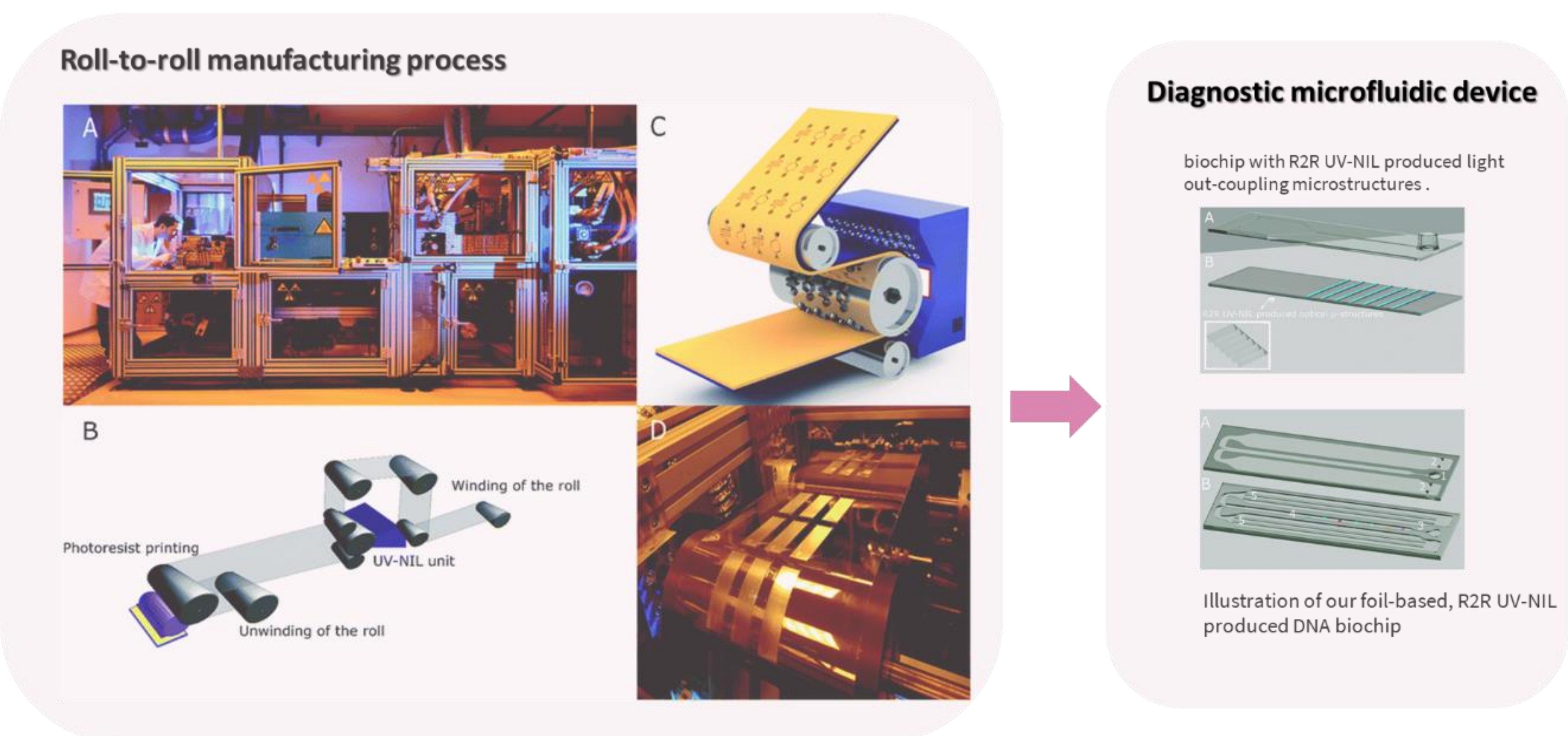

Figure 2. Roll-to roll manufacturing process and some representative microfluidic devices. [2]

Sustainability considerations:

- Contributing to the identification of chemical risks.
- Multiplexed detection of analytes. Reduction of tests per analyte.
- Low volumes for samples and reagents using miniaturized biosensors and microfluidics. From mL to µL or nL. Waste reduction.
- Miniaturized tubes for continuous monitoring of biomolecules.
- Cost reduction due to screening capability of microfluidic devices.
- Favoring home based testing.
- Designing re-usable and easy recyclable surfaces.

Safe-by-Design of the manufacturing process and the emergence of nanotechnology-based devices

Five demo cases are being used for the **Safety and Sustainability assessment.** All of them will optimize their biochemical and molecular assays for the selected antigen detection prior to their upscaling process. For upscaling, the R2R manufacturing process is being used.

Table 1. Safe-by design considerations in the five demo cases.

DEMO CASE 1 **Biosensors for Food Safety and Public Health Monitoring**	DEMO CASE 2 **Molecular Diagnostics for Sars-CoV-2**	DEMO CASE 3 **Smart Phone Enabled Home Diagnostics for Potassium in Blood**	DEMO CASE 4 **Cell Culture Devices for Pharmaceutical Testing**	DEMO CASE 5 **Sensors for Bio-Process Monitoring**
Development of a **molecular diagnostics assay** for the **multiplexed detection of SARS-CoV-2 and Influenza** as well as the **employment of aptamers for the detection of contaminants in food.**	Sensor chip production for a **molecular recognition platform in medical diagnostics** in general and for **Sars-CoV-2 diagnostics** (both antibody and viral genetic material testing) in particular.	Ion sensitive sensors for **home diagnostics with user friendly smartphone based read out** and for **PoC diagnostic instruments**.	Microfluidic chips for **neuron cell culture and axon outgrowth monitoring**, to investigate the formation and function of neural networks.	Microfluidic biosensors for **monitoring the activity and stability of enzymatic extracts** derived from enzymatic fermentation processes.
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Food Safety. Aflatoxin B1 monitoring **Medical Diagnostic** Sars-CoV-2 and Influenza detection	**Medical Diagnostic** Sars-CoV-2 detection	**Medical Diagnostic** Potassium detection	**Drug testing** Pharmaceutical drugs	**Industrial processing** Multienzyme monitoring
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Polymeric substrate. Large volume of chemicals in upscaling process.	**Safety issues of UV photopolymers used**	**Safety issues of screen-printing inks and nanomaterials used for sensing purposes**	**Laboratory waste management of plastics**	**Safety issues of possible nanomaterials in the sensor, bio detergents handling and safety issues**

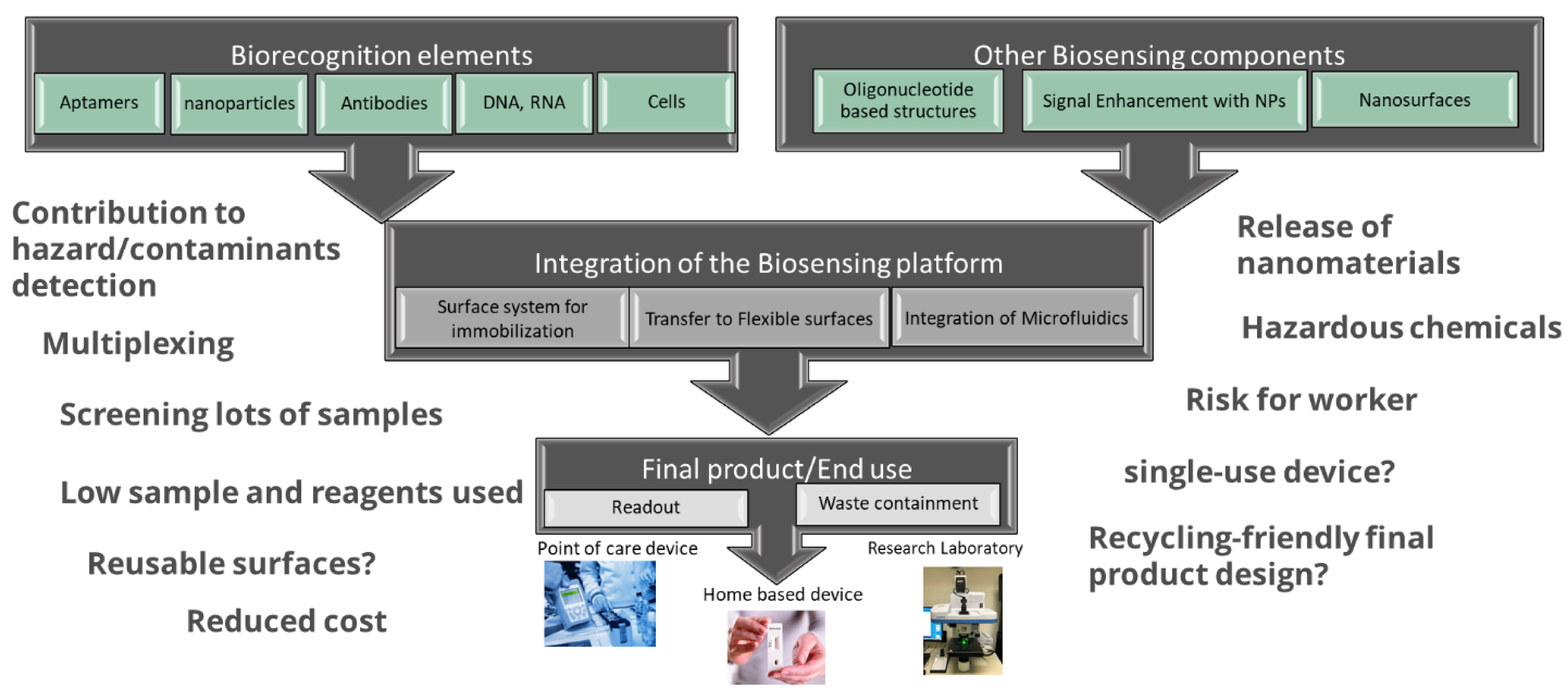

Figure 3. Safety and sustainability considerations of a biosensor and further microfluidic device integration.

CONCLUSION

Microfluidic Technologies and Applications facilitate new methods and multidisciplinary approaches in many different sectors and disciplines. Thus, microfluidics potentially affects medical fields, but also food and environmental safety as well as industrial monitoring. The technology has a high expectation at POC systems contributing to a more personalized medicine.

The NextGenMicrofluidics OITB will help in translating and accelerating new biosensor and assays at industrial scale in a safer and environmentally friendly scalable manufacturing technology as R2R imprinting. For that, considering Safety- and Sustainability-by-Design approaches in early innovation phases is important.

[1] ***Lab on a Chip***, 2018, **18**, 1552-1559 DOI https://doi.org/10.1039/C8LC00269J
[2] ***Lab on a Chip***, 2020, DOI https://doi.org/10.1039/D0LC00751J

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NextGen Microfluidics