Compact nanowire sensors probe emulsion droplets

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The fast evolution of high performance automated laboratory tests, point of care (POC) approaches for medical diagnostics [*1*], and smart routes towards new logic for chemical information processing [*2*] is to great extent driven by the smart combination of *microfluidics* and *nanotechnology*. In particular, droplet-based microfluidics (or digital microfluidics) - a versatile approach for operating a large amount of same size reactors in parallel is of particular interest, since it allows extremely parallelized and fine-tuned measurements, surpassing the precision of conventional assays. Although making an important contribution to classical detection and characterization laboratory assays, the application of droplet microfluidics in the spirit of miniature and light weight devices for *e.g*. POC applications remains a work in progress. The main impeding factor is related to the need for development and integration of novel *miniaturized optics-less* detection principle, outperforming the conventional approaches in terms of *e.g.* dynamic range or use of molecular labels.

Here we demonstrate a first combination of droplets microfluidics with the compact silicon nanowire field effect transistor in the microfluidic channel for ultrasensitive in-flow electrical detection of aqueous reactor-drops (Figure 1). Apart from detection events, we chemically probe the content of numerous (~104) independent reactors in a row, and resolve the pH values and ionic strength of the encapsulated solution, resulted in a change of a source-drain current through the nanowires. Optic-less and noninvasive measurements of these parameters in aqueous droplets can have a great impact on the area of biodetection and bioanalytics, where chemical processes performed in liquid environment are associated with the change of ionic composition or pH value in a medium. Finally, we demonstrate on a proof of concept level the GOx assay in droplets (enzymatic decomposition of glucose by glucose oxidase), measured simultaneously by SiNW FET sensor and integrated optical detector. Such realization of dual detection (SiNW sensor and optical luminescence) is demonstrated for the first time to the best of our knowledge [*3*].

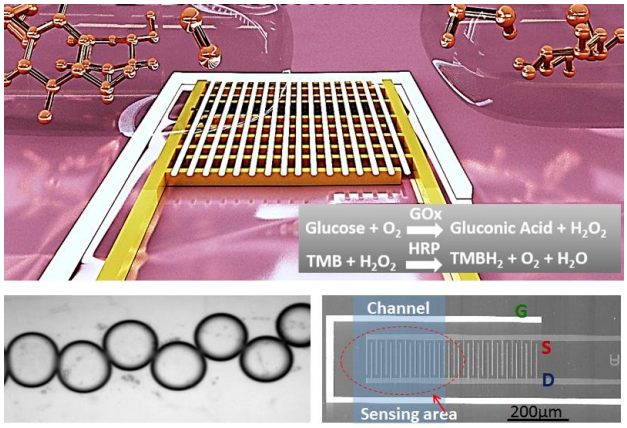

Figure 1: Conceptual description of the first combination of droplets microfluidics with the compact silicon nanowire field effect transistor in the microfluidic channel for ultrasensitive in-flow electrical detection of aqueous reactor-drops

References

[1] *Nature* **2007**, *450*, 1235.
[2] *Nature Physics* **2015**, 11, 58.
[3] *Nano Letters* 2016, 16 (8), 4991-5000.