Multiplexed sensing of steroids with silicon nanowire field effect transistors

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The simultaneous detection of multiple targets within a single chip on a point-of-care device is a milestone drawing great attention within bio- and nanotechnology areas for more than a decade [1]. Here, we demonstrate a multiplexed, label-free and real-time detection platform for small molecules like hormones and steroids, based on top-down fabricated silicon nanowire-based field effect transistors (SiNW FETs). The honeycomb-structured devices offer noise reduced, versatile and reliable electrical characteristics with high on/off ratios up to 1.7x 10^6 as depicted in figure 1.

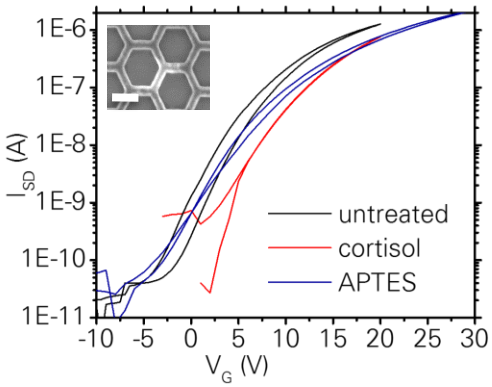

Figure 1. Transfer characteristics of silicon nanowire based field effect transistor upon different surface functionalization. Inset: SEM image of silicon nanowires with a scale bar of 200nm.

Monitoring of steroids plays an important role in the treatment of chronically stressed persons and professional groups, detection of dopants and inherent drug abuse, or simply for hormone screenings. Multiple SiNW FETs connected to a CMOS multiplexor chip enables the readout of up to 32 FETs simultaneously. We particularly focus on the sensitive and selective binding of the targets onto the SiNW FETs by using aptamers as receptors in order to allow high sensitive screenings in more physiological conditions [2]. In order to detect specific targets single FETs are functionalized individually by nanoprinting. Fluorescent microscopy confirmed target-receptor binding directly on the FETs. Figure 2 shows optical and electrical signals taken on the same FET after biorecognition process.

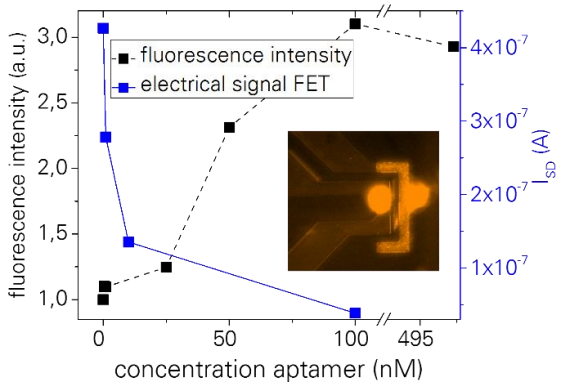

Figure 2. Fluorescence intensity signal of differently concentrated target aptamer on SiNW FETs and corresponding change of source-drain-current of the same FET.

Finally, we show the working multiplexing principle in form of the biochipbox that serves as a portable, electro-microfluidic device allowing the versatile and reliable point-of-care detection of multiple samples on one single sensor device.

References

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[2] Römhildt, L.; Pahlke, C.; Zörgiebel, F.; Braun, H.-G.; Opitz, J.; Baraban, L.; Cuniberti, G. ACS Appl. Mater. Interfaces, 22, (2013), 12029–12035.