Microfluidic Biosensors for in-vitro diagnostic of tumour markers

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Significant advances are made in the field of diagnostics of blood parameters. Recent works in research and development of the so-called lab-on-chips have shown promising results for rapid, sensitive, and low-cost point-of-care diagnostics. On this basis a microfluidic biochemical sensor is designed, fabricated, and characterized for the detection of tumor markers.

Microfluidic is the field of microsystem technology which handles small volumes of fluids. High interest of research and strong development over the last decade has led to numerous innovative applications, mainly used in drug research, genome analysis, environmental analysis, and diagnostics using so-called lab-on-chips. Hence, a successful implementation requires the bundling of interdisciplinary know-how and an intensive dialogue between engineers, scientists, and physicians.

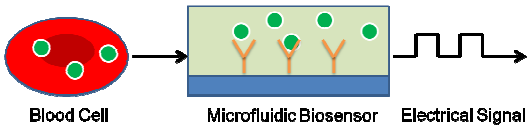

Fig. 1 Schematic diagram of a microfluidic biosensor with immobilized receptors (orange) on the surface and target analytes (green).

The combination of microfluidic and biochemical technologies allows the development of microfluidic biosensors for medical applications. A microfluidic biosensor can be defined as an analytical device in which a biologically active component (receptor) is immobilized onto the surface of an electronic transducer, allowing the detection of target analytes in a viscous liquid medium [1] (s. Fig.1). Thus, the change of mass on the surface or the corresponding change of the dielectric behaviour gives a clear indication of the existence of target analytes, like tumour markers or pathogens. An online detection mechanism would enable a reliable and quick analysis, which again leads to an improvement in on-time diagnostics.

The objectives of the MICROBIOMED project is the development and fabrication of a modular, sensitive, selective, low cost, and point-of-care in-vitro diagnostic system based on microfluidic technologies.

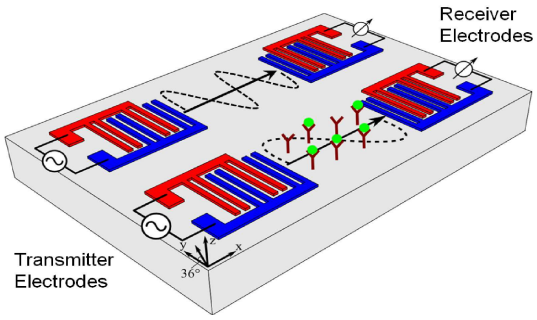

Fig. 2 Working principle of a SAW biosensor

In the project, IWE1 is responsible for the development and fabrication of microfludic devices. To figure out the best working sensor principle, we investigate two promising sensing methods, the surface acoustic wave (SAW) sensor technology (s. Fig. 2 and 3) and the electrical impedance spectroscopy (EIS) (s. Fig. 4 to 6).

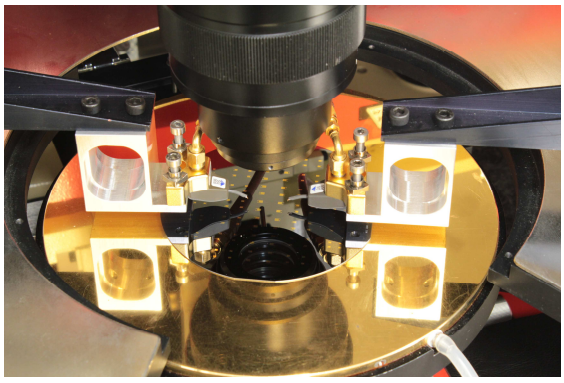

Fig. 3 On-Wafer electrical characterization of SAW sensors

Figure 2 shows the working principle of a SAW biosensor. The binding analytes (green dots) slows the propagation velocity of the SAW, which leads to a characteristic change of the resonant frequency. Figure 3 shows the first SAW-based sensor chips in a probe station.

Figure 4 shows schematic drawing of the EIS measurement setup.

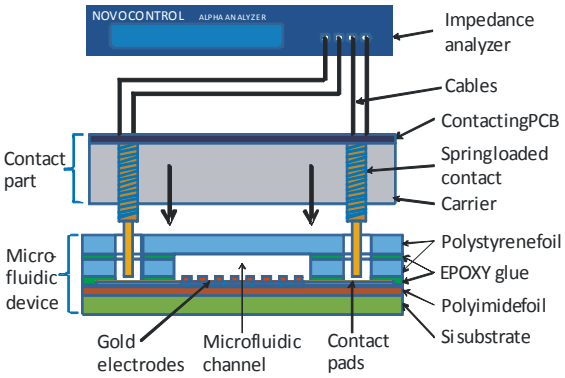

Fig. 4 Schematic drawing of the EIS measurement setup

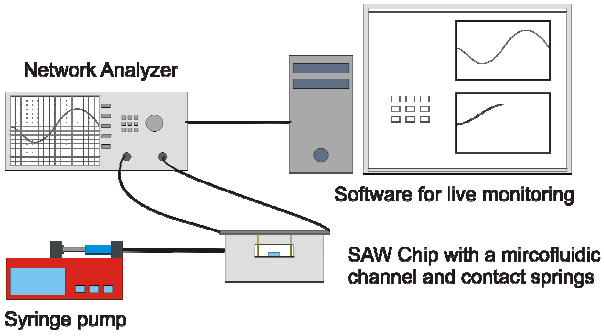

Fig. 6 Schematic drawing of the measurement setup for EIS measurements

The used chip comprises a U-shaped microfluidic channel with six detection spots for simultaneous EIS measurements at the same time (s. Fig 5).

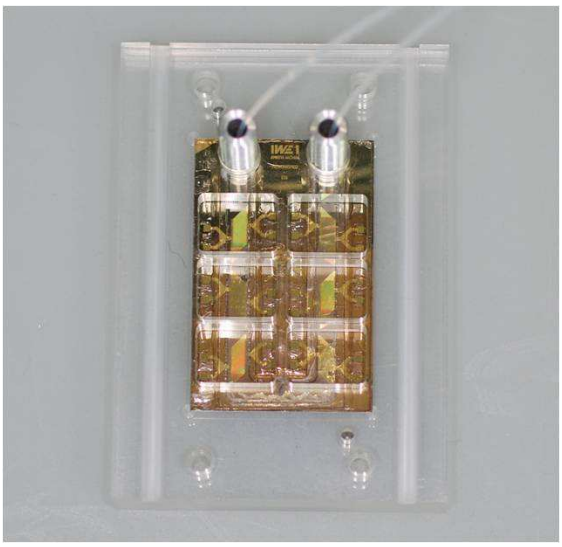

Fig. 5 Integration of multiple sensor chips into a micro-fluidic system to analyze liquid samples

To carry out automized biosensing experiments a custom-made measurement software is written to control the fluid flow in combination with online monitoring of the electrical signals to directly observe the binding events during an ongoing experiment (s. Fig. 6).

Different immunoassays are under characterization.

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[1] M. Rocha-Gaso, C. March-Iborra, A. Montoya-Baides and A. Arnau-Vives, Sensors Vol.9 (2009), p. 5742, ISSN 1424-8220