INTEGRATED OPTICAL SENSORS FOR DISPOSEABLE MICROFLUIDICS

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Optical chemical sensors are established process monitoring tools in industry and research laboratories. Optical chemical sensors basically comprise of luminescent indicator dye based in a host polymer. They are easy to integrate, non-invasive, do not need any reference element and can be read-out contactless from outside. However, to fully exploit the potential in microfluidic or organ-on- chip devices, the sensors have to fulfil several demands including high brightness, capability to be applied as thin film, excellent photo-stability, cheap and accurate read-out systems, ease in use (simple calibration and drift free), simple mass production compatible preparation steps, compatibility with the chip materials, resistance towards γ-sterilisation and no toxicity.

We present sensors for oxygen and pH fulfilling these demands. Our sensors can be excited with red-light and emit light in the near infra-red range (<700 nm). This suppresses background fluorescence and scattering from biological material. Sensor layers or spots are deposited with inkjet-based micro-dispensing or air-brush spraying with good adherence on glass or polymeric materials. A modified miniaturized phase-fluorimeter in a foot-print of a memory stick enables the read-out of sensor sizes below 100 micrometers. The sensor enable dynamic cell culturing and monitoring of cell metabolism in a microfluidic environment. We will give examples of oxygen sensors in a organ-on-chip model and pH sensors in cell cultures.

In addition, luminescent nanobeads are demonstrated as an attractive alternative to integrated sensor layers since they can be easily injected to the flow, do not interfere with the sample and have fast response times. We want to show the practical use of different pH and oxygen sensitive beads produced via staining of nanoparticles or nano precipitation. We present various examples of applications of nanobeads in microreactors to monitor and control biocatalytic reactions, cell based assays or bacterial growth in droplet reactors.

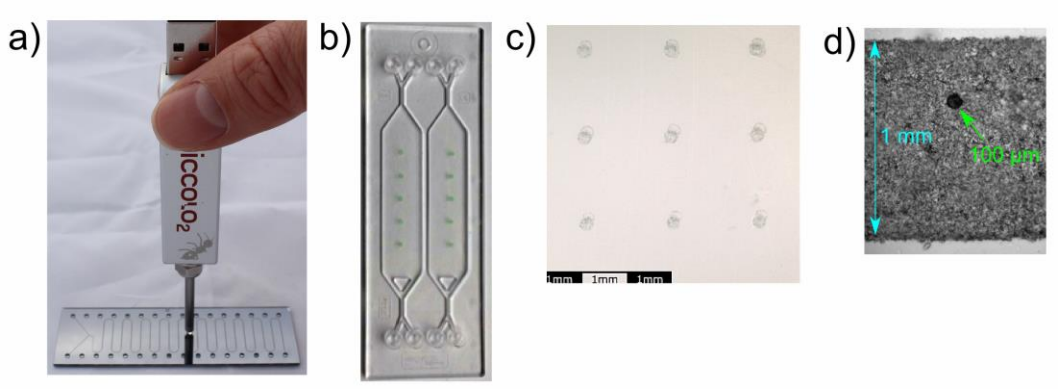

Figure 1: a) Miniaturized luminescence life-time sensor read-out instrument for microfluidic systems. b) Integrated sensor layer spots in a chip (microfluidic Chipshop) for cell-culturing applications c) Examples of oxygen sensor spots with a diameter of 300 µm produced with a microdispenser d) Integrated sensor spot on a glass surface (black dot) with a diameter of 100 µm prepared by air-brush spraying using stenci