Biophotonic Sensors on a Microchip for Trace-gas Detection, DNA and Enzyme Analysis, Raman Spectroscopy, and Optical Coherence Tomography

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Use of optical principles for the detection and analysis of biomolecules and biotissue has a long-standing tradition, and highly sensitive optical methods have been developed. Integration on a microchip offers cost reduction and instrument miniaturization, thus enabling novel applications, but also allows reduced biosample volumes, higher sensitivity, and faster acquisition times. We demonstrate optical sensing with Bragg-grating cavities inscribed into optical waveguides for label-free sensing of antibody-antigen protein reactions and H_2 gas sensing by stress-induced Pd-receptor microcantilever deflections. Furthermore, we introduce the method of modulation-frequency-encoded multi-wavelength fluorescent DNA analysis in an optofluidic chip during capillary electrophoresis separation, enabling detection down to the single-molecule level and allowing simultaneous analysis of DNA fragments from independent human genomic segments, associated with genetic predispositions to breast cancer and anemia, in a single experiment. Finally, by integrating wavelength-selective arrayed-waveguide gratings on a microchip, we demonstrate on-chip Raman spectroscopy and spectral-domain optical coherence tomography of biotissue.