Nanosensors for Life science applications

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Our research center of excellence IDUN combines research in nanosensors/centrifugal microfluidics and microfabricated devices for oral drug delivery. This allows us to explore the synergy between sensor development and search for new pharmaceutical delivery tools and materials. Our developed nanosensors get access to unique polymers and biomolecules and are able to characterize, among others, small volumes of materials and molecules, which are today not possible to analyze by any standard technologies. We will show examples of recent findings and results within drug/polymer characterization, diagnostics and process monitoring.

As part of our sensor integration we explore optics and mechanics from a DVD player. By rotating a polymer disc with integrated microfluidic channels it is possible to manipulate liquid samples such as blood – performing crucial operations like separation, valving and mixing. We integrate sensor elements such as cantilevers, nanoparticles, resonating strings and surface enhanced Raman scattering (SERS) substrates [1] with centrifugal microfluidics. The sensors are read out by a DVD pick-up head, which can perform transmission/absorption measurements and can detect nm deflections. Also, electrodes are integrated on a disc platform, facilitating electrochemical measurements.

By monitoring the resonance frequency shift of micrometer sized strings or cantilevers coated with thin layers of polymers, it was possible to monitor phase transitions using only ng of material. These systems also allowed us to monitor degradation of biomaterials used in the fabrication of the microcontainers [2]. Strings are inherently sensitive to temperature changes. The resonant frequency detunes as a function of temperature. This effect has been used to perform photothermal IR spectra on samples deposited on resonating strings and resonating filters. This has been used to study the amorphous and crystalline forms of indomethacin [3]. Centrifugal microfluidics and SERS has been used for the characterization of biofermentation products (drug compounds) in complex sample matrices [4].

References

[1] Durucan, O. et al. Nanopillar Filters for Surface-Enhanced Raman Spectroscopy, ACS sensors 2 (10), 1400-1404 (2017)

[2] Ceccacci, A. C. et al. Blu-Ray-based micromechanical characterization platform for biopolymer degradation assessment. Sensors Actuators B Chem. 241, 1303–1309 (2017).

[3] Kurek, M. et al. Nanomechanical Infrared Spectroscopy with Vibrating Filters for Pharmaceutical Analysis. Angew. Chemie 129, 3959–3963 (2017).

[4] Morelli, L. et al. Injection molded lab-on-a-disc platform for screening of genetically modified E. coli using liquid–liquid extraction and surface enhanced Raman scattering Lab on a Chip 18 (6), 869-877 (2018)

Figures

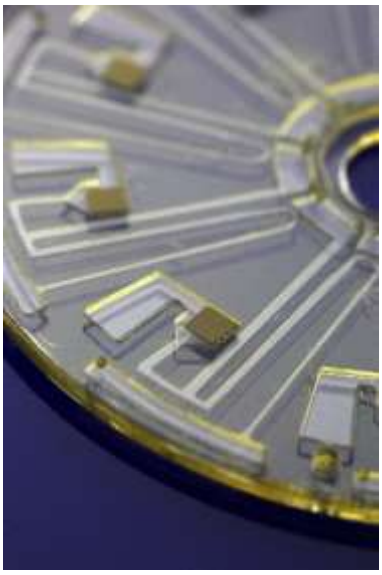

Figure 1. Example of nanopillar SERS substrate integrated into a centrifugal microfluidic system.