

Integrated Sensors and NanoPhotonics for Soft-matter Processes

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Abstract:

During the past decade, the need of more and more precise measurements of small-scale phenomena became a major challenge for both fundamental research and industrial applications. Indeed, several fields of research such as soft matter physics, biophysics and medicine need to track different kinds of phenomena at the micron scale. Regarding the industrial needs, it is in certain cases crucial to monitor atmosphere composition or to detect undesirable chemical species in a solution for safety. During the past few years, integrated micro-resonators have emerged as good candidates to meet these needs thanks to the low limit of detection and the high sensitivity achievable with such devices. In such a work, we present the results of the use of photonic micro-resonators for various sensing applications. The guiding and resonant structures are made of polymer DUV210 [1] and fabricated by the mean of deep-UV photolithography in a class 100 NanoRennes cleanroom [2]. The device is composed of an access waveguide coupled to a serial of racetrack shaped resonators by light tunnel effect [3]. The chip is then placed on an injection bench to perform the measurements. The injection bench is composed of a broadband laser source of central wavelength $\lambda_0 = 790$ nm and full width at half maximum FWHM = 40 nm, a polarizer to polarize the light and microscope objectives to focalize and de-focalize the light at the input and the output of the chip respectively. After the chip, a separating cube drives the light to both a CCD camera to monitor the injection, and an optical spectrum analyzer to measure the transduced and quantified spectra. The use of a broadband laser allows generating a frequency (or wavelength) comb through the resonators, which is determined by both opto-geometrical features of the device and its surrounding. By depositing a reactional medium on the chip, the variations of the shape of the overall quantified comb is then directly related to the kinetic of the reaction. The relevant characteristics of the frequency comb to track are the free spectral range, the quality factor of the resonance and its associated finesse. These characteristics are directly related to physical phenomena occurring in the surrounding of the integrated probe light so by tracking those, the following of different kinds of reaction is achievable. In this work, we present the use of integrated micro-resonators in several applications yielding different intrinsic physical properties. The first application concern the detection of sparsely

concentrated glucose solution [4], the second one deals with the dynamic following of steam condensation/evaporation process and the last application is about the detection of a gel/fluid phase transition of sphingolipids [5].



Figure 1 Photography of the experimental set-up.



Figure 2 Upper-view of the resonators under injection.

References

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