Functionalized silicon Fabry-Perot microcavities for chemical vapor sensing

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Fabry-Perot microcavities based on two Bragg mirrors vertically etched in silicon are filled with gas permeable polymers (Figure 1). As the polymer absorbs gas, its refractive index changes, which induces a shift of the resonance wavelength of the cavity. The magnitude of this shift depends on the concentration of the targeted gas in the vicinity of the cavity and on the refractive index difference between the polymer and the gas.

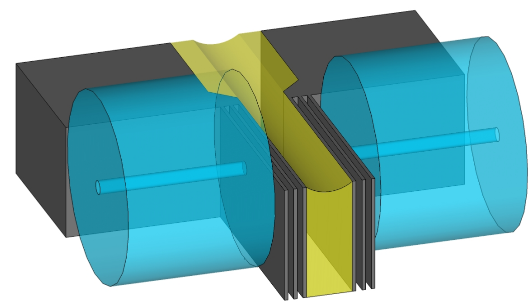

Figure 1: Schematic of the silicon (grey) Fabry-Perot cavity filled with the polymer (yellow). The cavity is made of two silicon-air Bragg mirrors and is interfaced with single mode optical fibers (blue).

The main advantage of this Fabry-Perot resonator is its ability to perform volume refractive index sensing, in contrast with evanescent wave sensors such as tapered optical fibers or on-chip waveguided resonators. This greatly simplifies the coating of the device since surface effects occurring at the interface of the polymer and the resonator become negligible, and since the initial refractive index of the polymer does not need to be matched to that of the waveguiding structure.

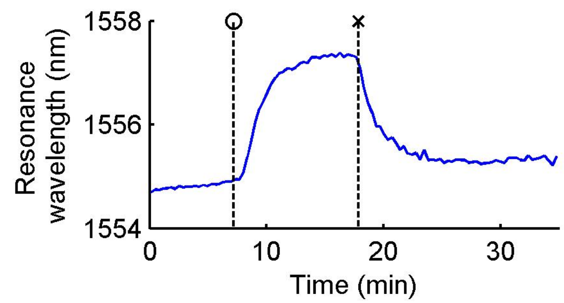

Figure 2: Resonance wavelength of the cavity after exposition to 120 ppm of xylene (O) and to pure nitrogen (X).

Preliminary results for a cavity filled with a poly (diphenyl siloxane) - poly (dimethyl siloxane) copolymer and exposed to xylene vapor yield a linear sensitivity of 0.015 nm/ppm for concentrations between 120 (Figure 2) and 1300 ppm. Future work will involve testing of other gases and other polymers over a wider range of concentrations.