

SILICON MICRORING RESONATORS SURFACE FUNCTIONALIZED WITH ORGANIC AND INORGANIC FILMS FOR VOLATILE ORGANIC COMPOUND (VOC) DETECTION

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A wide range of industrial, environmental, medical as well as scientific applications employ gas detection units. Despite the existence of different gas sensing technologies, various limitations in these technologies have always driven the interest for better solutions. A close to ideal gas detection technology is one which is sufficiently sensitive and selective, low energy consuming and low cost, of a fast response and recovery, flexible enough for sensor array implementation, highly portable, and simple.

In this respect, bio-chemical sensors implemented on highly compact, and CMOS compatible silicon photonic technology have recently attracted a considerable attention in the scientific and gas sensing community. Combining its miniaturized features with the mature CMOS fabrication, silicon micro/nano photonic technology is inherently suited for multiplexed, ultraportable, and low cost on-chip sensor implementation. Microring resonators with dimensions as small as 5 μ m are one of the silicon photonic structures which have demonstrated a high promise for gas and bio-chemical detection.

We experimentally demonstrate the promise of organically and inorganically surface functionalized silicon –on-insulator (SOI) microring resonators (MRRs) as volatile organic compound (VOC) sensors. The detection of VOCs such as benzene, toluene, hexane, and xylene, is highly instrumental in occupational health safety monitoring in industrial and workplace settings. In this work, we have coated SOI microring resonators with 100- 150nm thick Polydimethylsiloxane(PDMS) , and ZnO nanoparticle films and evaluated their response to xylene vapor. We demonstrate that ZnO coated MRRs have a higher sensitivity and can detect below 1ppm xylene. However due to the strong interaction between the ZnO surface and xylene molecules, these sensors show partial reversibility. Figure 1 shows the measured MRR resonance shift as a function of xylene vapor concentration.

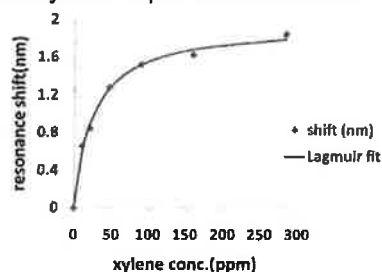


Figure 1 resonance shift measured from porous ZnO film coated MRR at different xylene vapor concentrations

On the other hand, PDMS coated MRRs are demonstrated as suitable for the detection of xylene vapor concentrations higher than 500ppm. Remarkable reversibility, very fast as well as linear response is achieved from these sensors. The response and the almost 100% recovery time of the sensors are 30 and 45 seconds respectively. Figure 2 (a) and (b) show the sensitivity curve, and the response and recovery trend respectively.

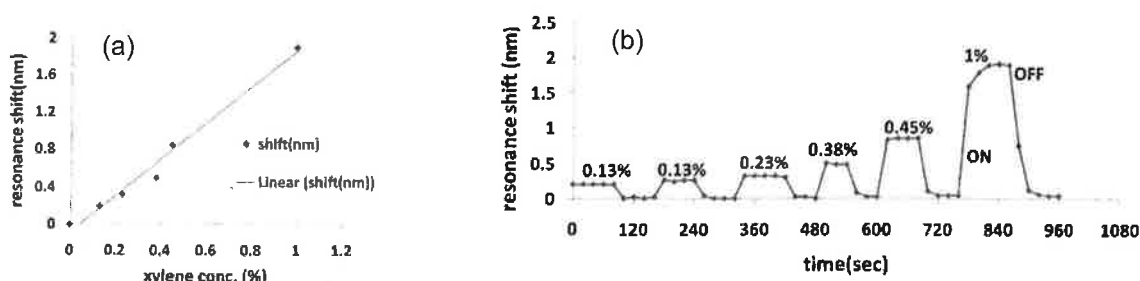
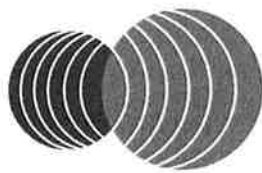


Figure 2 PDMS coated MRR (a) resonance shift (b) response and recovery time, at different xylene vapor concentrations



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