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Photonic crystal waveguides integrated with microcantilevers as a novel platform for gas sensors

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We present results related to the simulation and fabrication of a novel and highly sensitive mechano-optical sensor for gas detection (i.e., hydrogen gas) based on microcantilevers, supplied with a selective gas absorption layer, suspended above a Si_3N_4 grated waveguide (GWG). The presence of a dielectric object, in this case a suspended cantilever, in the evanescent field region of the GWG may lead to the occurrence of propagating modes for wavelengths inside the stop band of the grating, and so to defect modes inside the stop band. These modes introduce sharp features in the transmission spectrum of the device. These features are quite suitable to monitor stress induced bending of the cantilever owing to concentration changes of the gas for which the absorptive layer is sensitive.

The 2D bidirectional eigenmode propagation (BEP) method has been applied to analyze the effect of cantilever displacement on the optical transmission spectrum of the GWG. The simulation results show that as the cantilever approaches the grating, the first near band-edge resonance peak is pulled inside the stop band and its spectral width decreases. The resolution of displacement measurement is estimated to be 0.2 nm for a 200 nm thick cantilever at a 200 nm initial gap, assuming a signal-to-noise ratio (SNR) of 20 dB.

Integrated microcantilever-GWG devices have been fabricated successfully using MEMS techniques. Uniform gratings have been defined with laser interference lithography. SiO_2 cantilevers with low initial bending (i.e., low stress) have been fabricated by combining the tetra-ethyl-ortho-silicate chemical vapor deposition (TEOS-CVD) and plasma-enhanced chemical vapor deposition (PE-CVD) oxides, and by releasing them using a **tetramethylammonium hydroxide** (TMAH) wet-etching solution to remove the sacrificial poly-Si layer, followed by a freeze-drying process. Currently we are optimizing the fabrication process to achieve cantilevers with low initial bending. Detailed results, also discussing the potential of the integrated microcantilever-GWG as a novel and compact mechano-optical sensor for hydrogen gas, will be presented during the conference.

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