Mechano-optical sensors for hydrogen gas: Fabrication and Proof of concept

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Abstract

We present results related to the fabrication and the proof of concept of a novel and highly sensitive mechano-optical sensor for hydrogen gas, based on microcantilevers, supplied with a selective gas absorption layer, suspended above a Si$_3$N$_4$ grating 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 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.

Integrated microcantilever-GWG devices have been fabricated successfully using MEMS techniques. Uniform gratings have been defined with laser interference lithography [1]. 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. Several technical problems encountered during the preparation of such integrated devices (i.e., stiction, surface roughness, facet quality) will be discussed and solutions to address these issues will be given as well. Cantilever-deflection induced spectral shifts of the transmission spectra, as a proof of the concept, were observed; results will be presented during the conference.

Key words: mechano-optical sensors, laser interference lithography (LIL), RIE, TMAH, freeze-drying.

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