PHOTOACOUSTIC spectroscopy utilizing AFM-based CANTILEVER detection

Z. Zelinger, P. Janda

J. Heyrovský Institute of Physical Chemistry AS CR, Dolejškova 3, 182 23 Prague 8 Czech Republic
The sensitivity in the photoacoustic spectroscopy is limited by the microphone. The replacement of a microphone with a cantilever one enhances remarkably the sensitivity of photoacoustic gas detection:


The combination of sensitive microphones and micromechanical elements with laser techniques - new approaches to photoacoustic detection and for chemical sensing possibilities.
graphene leafs: outstanding electromechanical properties and impressive sensitivity as a mass detector its utilization as nano/micro-lever sensing devices for chemical analysis:

We have tested:

• AFM-based silicon cantilevers in a square arrangement and
• graphene sheets in the form of a circular membrane.
Scheme of detection part consisting silicon cantilevers:
Membrane for photoacoustic detector has been prepared from multilayer graphene (MLG) by micromechanical cleavage which is an essential component of sheets stripped-off basal plane highly ordered pyrolytic graphite (HOPG, ZYH Grade, Bruker, USA): 

MLG leaves (thickness <10 μm) have been mounted on glass window of cuvette for photoacoustic spectroscopy and used for detection of acoustic waves by laser beam reflected to CCD detector.
Scheme of detection part based on graphene:
Experimental set-up

IR laser → chopper → HeNe laser → microphone → Det.

Detected MLG leafs movements

4 Hz

23 Hz
Comparison of the same concentration detection by microphone and graphene processed by lock-ins – laser radiation is ON or OFF.
Sensitivity levels of the investigated experimental set-ups have been tested by the utilizing of the concentration standards based on the permeation method in the flow regime.
ON and OFF concentration (~2 ppm) for microphone and graphene detection:
• silicon cantilevers and multilayer graphene (MLG) leafs as photoacoustic detectors.

• future:
few-layer graphene (FLG) cantilevers/membranes, prepared by CVD technique and transferred to support, allowing free-standing mounting.
Many thanks for your attention!