A Microfabricated Gas Analysis System

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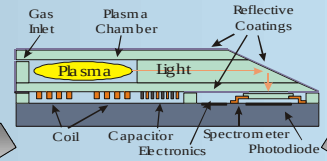
Goal: to create an integrated microsystem consisting of a gas plasma and a microspectrometer that is capable of detecting air-borne contaminants with a detection limit of approx. 1 ppm.



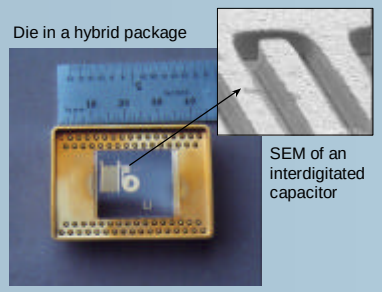
System Concept

Challenges: Optimize photon generation (plasma) and collection (optics)
Increase resolution of the FPI (mirror reflectivity, position)
Address system integration and parasitic interactions

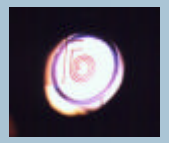
MEMS Plasma Generator

A low power, electrodeless plasma source on a chip

Die in a hybrid package



SEM of an interdigitated capacitor



Plasma viewed from the top

Side view of an air plasma below the hybrid package

Applications

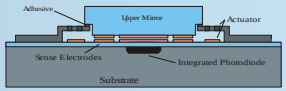
- Chemical analysis: optical and mass spectroscopy
- Low temp. sterilization of BioMEMS devices
- Array-addressable materials processing
- Microthrusters for miniature space craft

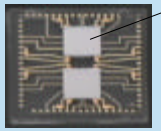
Operation

- Electrodeless inductive coupling allows use with chemically ***reactive gases***
- Low power (300 mW - 3 W), low voltage (< 20 V)
- Gas pressure: 0.1 - 10 Torr (13 - 1300 Pa)
- Argon ion density: 10^{10} - 10^{11} cm^{-3}
- Electron temperature: 20,000 - 50,000 K
- Non-equilibrium plasma allows operation near room temperature, however.

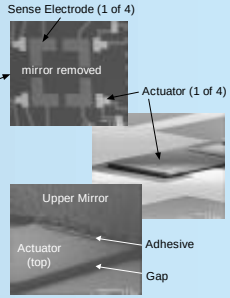
Microfabricated Fabry-Perot Interferometer

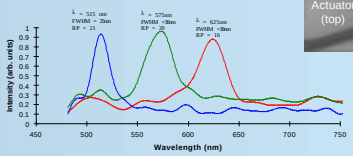
An electrostatically-actuated optical filter





1 mm Mirrors (top view)





Experimental Performance of the Micro FPI with Aluminum Mirrors

Applications

- Analytical Emission Spectroscopy
- Colorimetry
- Optical filtering/communications

Operation

- Free spectral range covers visible spectrum in the first order
- Higher resolving power by using higher orders
- Electrostatic actuation voltage: 20-100 volts
- Capacitive sense electrodes used to determine mirror position and wavelength
- Separately fabricated and assembled mirrors allow high reflectivity

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