

MICROPLASMA-BASED SPECTROSCOPIC MICRODEVICE FOR BOTH ATOMIC AND MOLECULAR BASED GAS DETECTION

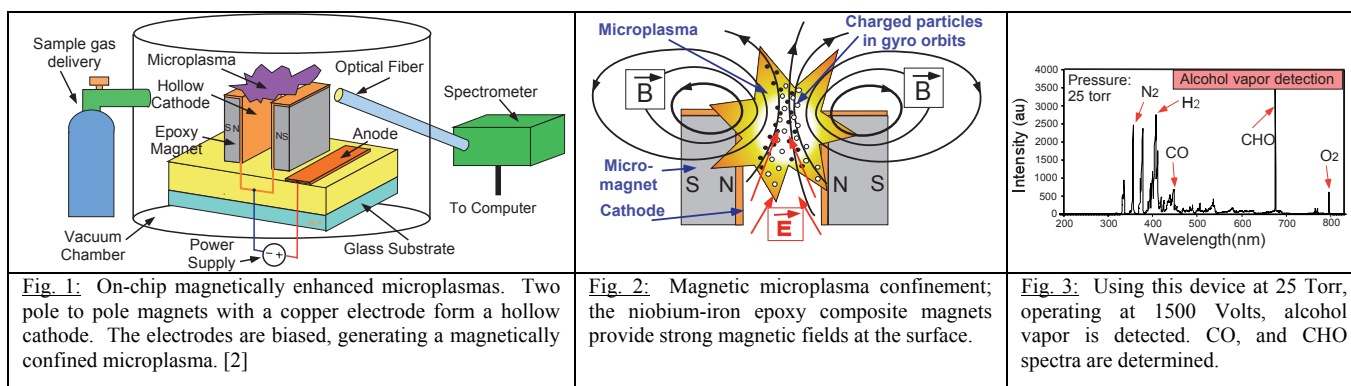
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Background: There is an obvious need for a portable, inexpensive, and highly sensitive and specific toxic and explosive gas detector. Tin-oxide gas sensors are one of the most prevalent MEMS gas detectors, but lack the ability to distinguish between different gas types [1]. This is because the measurand is conductivity, which is sensitive to many things. Plasma spectroscopy is specific to gas type as the spectral emissions produced are comparable to a fingerprint, revealing the chemical composition of a gas. Specific molecular gas information is critical to sensors measuring chemical weapons; current detectors are plagued by false positives. In plasma spectroscopy, gas molecules are broken up in the plasma and atomic spectra is observed, but determination of the molecules present is inexact. Typical plasma spectroscopic gas detectors are the size of a graduate student's cubicle. Our group is developing a small scale microplasma-based spectroscopic gas detector, enhanced with local magnets, and time pulsed to optimize both atomic and molecular spectra.

Magnetically Enhanced Microplasmas: In the past our group has used magnets to confine and enhance the glow region of on-chip microplasmas (Fig. 1) [2]. The microdevice utilizes two opposed magnets which form a cavity, coated with a patterned copper electrode, which forms a micro-hollow cathode. The local magnetic fields crossed with the applied electric fields confine the electrons in gyro-orbits (Fig. 2). Gas is flowed through the system, and a fiber optic lead to a spectrometer allows the gas to be characterized. The magnets create circular fields at the top of the device where the electric field is highest, confining electrons in this region to circular orbits, increasing ionization. When exposed to alcohol vapor, the device is able to measure the alcohols molecular constituents, as well as the nitrogen background gas (Fig. 3).

Time Pulsed Afterglow Analysis: The magnetic spectroscopic gas detector, created previously does produce strong molecular emissions, however specific molecular information is still lacking. The CHO fragments that are detected in the alcohol sample, for instance, could have come from acetone or benzene. We are developing a similar spectroscopic gas detector that will be able to detect both atomic and molecular spectra, by time sequencing the voltage bias. Afterglow spectroscopy is being used, and the recombination spectra of the various molecular components is being recorded, providing specific molecular information.



References: [1] M. Madou, Fundamentals of Microfabrication, [2] R. Yalavarthy, et. al., "S-MAyHEM: A Spectroscopic MicroAnalytical Hollow Enhanced Magnetron for Explosive Gas Detection," Accepted for Publication MEMS 2006

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