Pulsed Microdischarges and Their Use in Chemical Sensing

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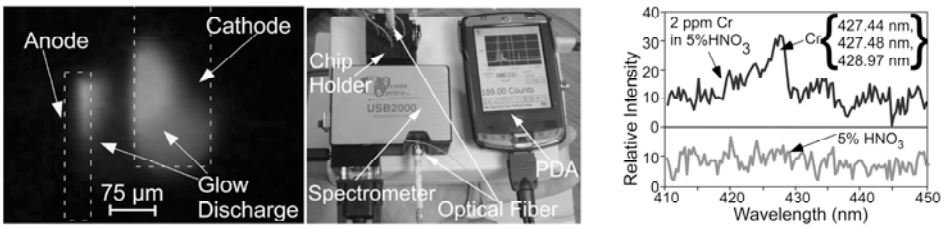

Left – The microglow discharge at 1atm pressure, Middle – The handheld system for chemical analysis, Right – Spectrum showing 427.5nm Cr line in 2ppm Cr solution.

This project investigates microdischarges at atmospheric pressures and their use in spectrochemical analysis. Spectroscopic methods of chemical detection offer the potential for high specificity, excellent sensitivity, and fast response time. Microdischarges have high-power density but do not require much energy. These characteristics make them ideally suited for GC detectors, and analysis of inorganic impurities in liquids. The devices are designed to operate without the use of a pump or carrier gas. The device relies on the principle that the emission lines in the spectrum of a microdischarge are characteristic of chemical species in it. For water chemistry, a microdischarge is struck between a metal anode and a liquid-filled cathode. The use of a porous cathode provides efficient means for delivery of a small quantity of liquids into the discharge. The device was shown to detect 2ppm of Cr in water. The gas discharge microchip uses microdischarges in air between closely spaced metal electrodes. For small electrode gaps, the discharge can take the form of an arc, a glow discharge, and intermediate arc-plasma hybrid. The properties of this discharge can be tailored electronically to suit the application. A three-electrode (FlashFET) version of the device employs separate high-voltage and current electrodes to power microdischarges with very low energies. This device consumes only 22μJ/cycle. A battery-operated microdischarge sensor system, employing swappable liquid and gas microdischarge chips, has been implemented for practical use of these sensors. This project was supported by the NSF under an independent award in the past, and was subsequently supported by the Engineering Research Centers Program of the National Science Foundation under Award Number EEC-9986866.