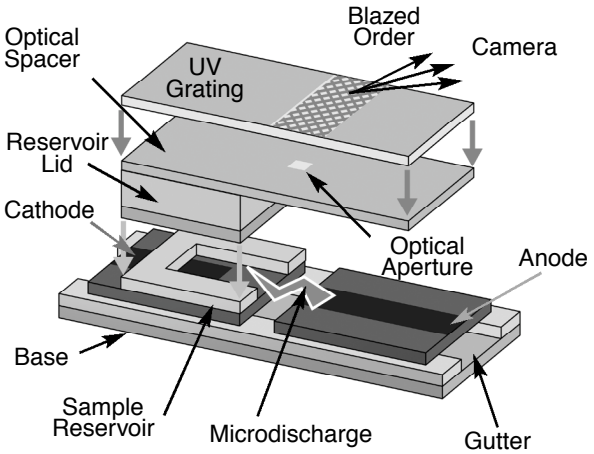
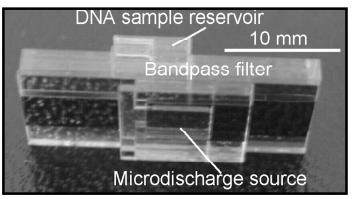
High-Speed Chemical Sensing Using Microdischarges

Bhaskar Mitra, Chester B. Wilson, Long Que, and Yogesh B. Gianchandani



A schematic of the water spectroscopy microsystem showing the integrated microdischarge source and dis - persion optics.



A picture of the device used to detect DNA by fluorescence showing the microdischarge source, an integrated bandpass filter and the DNA sample reservoir.

This project explores the use of spectral emission of microdischarges to detect chemicals in the environment. Spectroscopic methods of chemical detection offer high specificity and fast response time. On-chip microdischarges offer a low cost, portable, and efficient way to distinguish chemical composition and concentration by spectral emission detection. In the present work, we are using these for detecting metal impurities in water and for detection of biomolecules by direct and indirect fluorescence. Both use a liquid electrode spectral emission chip (LEdSpEC) as the core technology. For detecting impurities in water, a microdischarge is struck between a metal anode and a liquid cathode. The dissolved metal ions are sputtered into the glow region, and their atomic transitions generate light that is used to uniquely identify the particular metal impurity present. This permits us to detect trace amounts of contaminants like chrome and lead in liquid samples. For detecting biomolecules by fluorescence, the LEdSpEC is used as a tunable light source by doping the liquid with a metal salt. The generated light, corresponding to the metal, is of the wavelength required for exciting the spectra of the fluorophore. This results in a battery-operated microfluidic emission source for a variety of wavelengths, including those in the UV range. For example, DNA tagged with SYBR green dye can be fluoresced and detected. In addition, direct fluorescence of tryptophan, an amino acid, has been demonstrated with an on-chip microfluidic device for the first time. The related microplasma research has been supported by National Science Foundation under Award Number ECS0233174. Other components of this effort were supported by the USGS and the Sea Grant.