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Microchip conductivity/dielectric constant detectors - setting a new benchmark for ultrasensitive, low volume detection

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We have explored novel microchip conductivity detectors with two different planar geometries – a "sensor" geometry with nanoscale electrode separation designed to sense molecules on its surfaces, and a "detector" geometry with more widely spaced electrodes designed to detect molecules in solution. In one series of experiments, the sensitivities of microchip devices were tested by incorporating them into a high performance liquid chromatograph (HPLC) equipped with a UV-Vis detector, injecting a variety of molecules and monitoring the detectors' responses simultaneously. Both microchip geometries exhibit great sensitivity to charged species (such as acids and ions), typically exceeding the sensitivity of UV-Vis detection. Surface sensitivity of the "sensor" geometry is confirmed by varying surface treatment of the microchip and observing a change in response. We also demonstrate utility of the microchip devices to bench-top/portable formats with real time computer data handling. For example, the sensor geometry responds to alcohol vapour, and the detector geometry responds to NaCl solutions with concentrations ranging from ~10's ppb to 100's ppm. (In ion chromatography, the microchip detector's limit of detection of ions is found to be even lower due to stability of background conductivity of water.) Due to the small cell constants of the microchip devices, they can also simultaneously be operated in dielectric constant mode, allowing for the first time operation in insulating solvents as well.The microchip devices' remarkable surface/volume (and potential for surface functionalization), sensitivity, low detection volume and robust performance suggest a range of promising applications, including biodetection.

Biography

Al-Amin Dhirani completed his Ph.D. in experimental surface physics at University of Chicago in 1996 and his postdoctoral studies in atom optics at MIT in 1998. In 1999, he accepted an assistant professorship in the Chemistry Department at University of Toronto and a cross-appointment to the Physics Department, and in 2004, he was promoted to associate professor. His current research focuses on nano electronics and novel analytical technologies. His awards include Hulda and Maurice Rothschild Fellowship (University of Chicago, 1995), Natural Science and Engineering Research Council Postdoctoral fellowship (MIT, 1997), and the Premier's Research Excellence Award (University of Toronto, 2000).

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