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Home Ozone Monitor Incorporating Low Cost High Performance Printed Gas Sensors

NIH SBIR Phase I: 1R43ES021676-01

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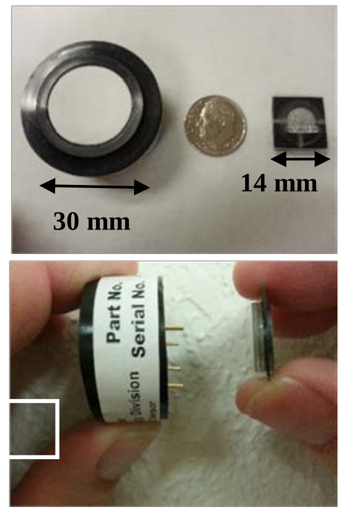
Need: Ozone (O_3) is toxic gas and respiratory irritant generated in the atmosphere generated by photochemical reactions of volatile organic compounds (VOCs) arising from anthropogenic sources. O_3 can cause severe distress in people with compromised respiratory systems, e.g., COPD or asthma. This can be especially dangerous for children and the elderly. Those at risk could be significantly aided by having a home ozone monitor in their residence, analogous to the smoke detectors and carbon monoxide alarms that are ubiquitous in modern buildings. Since O_3 levels become dangerous at very low concentrations (less than 100 ppb) realizing a home O_3 alarm represents a challenging development problem with a large commercial payoff.



Examples of printed gas sensors compared to conventional, amperometric sensor.

Approach/Results: The Phase I program demonstrated the use of room temperature ionic liquids (RTILs) as electrolytes for printed amperometric O_3 sensors. A set of RTILs, selected for superior chemical and physical properties with respect to ozone sensing and overall performance of the amperometric sensor, was tested. A set of working electrode catalysts was chosen based on our previous experience with amperometric sensor design and the specific problem of ozone sensing. These RTILs and catalysts were tested for key performance metrics. The best performing combinations were down selected for further investigations with the printed sensor format. Printed sensors were fabricated using several of the best performing combinations of electrolytes and electrodes. These were compared directly to a standard commercial sensor configuration which uses an aqueous acid electrolyte. The printed sensors performed as well as or better than commercial devices, in terms of the response time, sensitivity, limit of detection, baseline stability and temperature and relative humidity stability, illustrating that rational selection of RTILs can be used to fabricate superior performing gas sensors and that RTILs impart competitive advantage compared to the state of the art. *We also demonstrated that the RTIL based printed gas sensor could be used reliably as the transducer in an alarm actuator circuit at ozone concentrations relevant to environmental health issues (0 – 100 ppb)*. In this application, the printed sensor provided near real time response to changing ozone concentrations and its calibration was validated vs. a benchmark UV ozone analyzer.

Benefits/Innovation: The new sensors more stable and less subject to environmental interferences than the metal oxide semiconductor sensors used in commodity applications. In fact, the RTIL-based sensors are even more stable to temperature and RH changes than standard commercial amperometric ozone sensors. These sensors will provide a high reliability O3 measurement to make an in-home ozone monitor a reality.