CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

S0601

Project Title

Comparative Studies of Gold Nanoparticles as Chemical Sensing Materials: Electronic Tongue vs. Electronic Nose

Abstract

Objectives/Goals

The main goals of my project are (1) to develop simple, cost-effective, reusable electrochemical sensor arrays (electronic tongue and electronic nose) that can simultaneously detect Be2+, Cd2+, Hg2+, and Pb2+ in water and ethanol, dichloromethane, and carbon monoxide in the air and (2) to evaluate and compare sensing performances (e.g., detection limit, selectivity, and sensitivity) with respect to film morphology and the type of samples.

Methods/Materials

Gold nanoparticles (Au NPs) with ~1.6 nm core diameter were synthesized by a literature method. The synthesized Au NPs were functionalized with six different types of thiols (4 different crown ether thiols, thiolated polyethylene glycol, and mercaptoundecanoic acid) by ligand exchange reactions. The thin films of seven different types of Au NPs (six functionalized and one unfunctionalized) were individually casted on each of interdigitated array electrodes or high pressure electrodes to build electronic tongue or electronic nose.

Results

Both electronic tongue and electronic nose showed linear responses with specific metal ions and gas/vapors, respectively. The electronic tongue could simultaneously detect cadmium, mercury, lead, and beryllium at 0.1 - 2.6 ppb levels, while the electronic nose can simultaneously detect carbon monoxide, ethanol, and dichloromethane at 5.0 - 12.5 kPa levels. Selectivity was determined by calculating selectivity coefficients (ratios of interference response to analyte response). Both electronic tongue and nose could be reusable when they were cleaned with 0.1M EDTA solution (electronic tongue) or N2 gas (electronic nose).

Conclusions/Discussion

Compared with the previous year's electronic tongue (a non-linked film by drop-cast), the current year's electronic tongue (a linked film by self-assembly) showed better sensitivity, selectivity, and stability but similar detection limits and narrower dynamic range. The electronic tongue displayed better sensitivity and selectivity than the electronic nose. The response of electronic nose was less linear than that of electronic tongue. Based on the observed data analysis, it was concluded that (1) gold nanoparticles are versatile materials for chemical sensing, (2) the self-assembly technique is preferred to develop a better electronic tongue, and (3) the electronic tongue provides more reliable data than the electronic nose.

Summary Statement

I have developed electronic tongue and electronic nose that can simultaneously detect toxins in either water or air, respectively.

Help Received

All experiments were conducted at California State University - Fresno under the supervision of Drs. Hasson and Choi.