Electronic Tongue: Tastes of Toxic Metal Ions in Water

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The main objective of my project is to develop the simple, cost-effective, reusable electrochemical sensor (electronic tongue) that can simultaneously and accurately detect cadmium (Cd), mercury (Hg), lead (Pb), and arsenic (As) ions in water. For the project, I synthesized gold nanoparticles with approximately 1.6 nm core diameter and their surfaces were functionalized with four different types of crown ethers that can selectively form complexes with Cd(II), Hg(II), Pb(II), and As(III). The thin films of these gold nanoparticles were casted on four interdigitated array (IDA) electrodes, individually responsible for the detection of such metal ions. Then, four IDA electrodes were integrated to build an electronic tongue. When metal-crown ether complexes were formed on each gold nanoparticle film, its conductance and junction potential were changed. I measured them to quantitatively analyze the concentration as well as detection limits and sensitivities of metal ions. Each IDA electrode showed a linear response with a specific metal ion, except for the As(III)-sensing IDA electrode. The detection limits were determined to 0.5 – 24.0 nM (0.1 – 2.7 ppb) for Hg(II), Pb(II), and Cd(II). I obtained better detection limits and sensitivities when I determined those with junction potential rather than conductance. Selectivity was studied by determining selectivity coefficients over six interfering ions: K(I), Ca(II), Mg(II), and the other three analyte ions. Both conductance and junction potential measurements showed similar selectivities. For reusability test, my electronic tongue was washed with 0.1M EDTA solution and >98% of complexed metal ions were removed for next use.

Awards Won:
Third Award of $1,000