Flexible Sensors Based on Ligand-Capped Gold Nanoparticles: The Effect of Ligand Properties on Sensor Characteristics

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Flexible sensors based on a network of ligand-capped Gold Nanoparticles (GNPs) have been attracting significant interest, due to their ability to detect and measure multiple parameters such as strain, temperature, humidity and Volatile Organic Compounds (VOCs), through changes in their electrical resistance. My goal was to establish a better fundamental understanding of the underlying mechanism by which these sensors operate, specifically the effect of ligand chain-length and internal volume, as well as mechanical bending, on sensor performance. Such understanding should promote the development of enhanced sensing arrays. I manufactured seven different sensors, each containing GNPs capped with different organic ligands, varied by chain-length and volume. I exposed these sensors to different combinations of VOC-concentration-bending, and obtained the relative change in resistance for each sensor, as well as its sensitivity. Following this, I applied Principle Component Analysis (PCA) on datasets from different arrays of sensors to characterize array selectivity. Sensors with longer ligands showed higher sensitivity. Sensors with increased volume ligands showed better selectivity. Bending improved the selectivity of sensor arrays, but not necessarily the sensitivity. Following result analysis, I showed that combining data from sensors with long ligands and increased volume ligands will enhance the overall performance of the array. I also showed that each sensor has a bending limit which gives it maximum sensitivity, and at this limit, the sensors operate the fastest. Through further development, arrays of sensors could be formed to create flexible multi-parametric sensing devices - Which can, for example, be potentially used as artificial skin or for disease diagnosis.