Gold Nanoparticles Chemiresistors: towards e-tongues for Ions Sensing

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The combination of metal nanoparticles (NPs) with ad hoc supramolecular receptors of the analyte of choice represents a poweful strategy for the fabrication of novel hybrid plasmonic sensors.[1] On the one hand, AuNPs are ideal scaffolds because of their highest surface-to-volume ratio combined with their unique optical and electrical properties.[2] On the other hand, supramolecular recognition has proven to be key to the realization of sensors exhibiting detection limits down to ppm/ppb levels with fast response speed combined with unprecedented selectivity.[3]
Here, we have devised a novel chemiresistor (CR) capable to perform real-time sensing of ions. Such devices are based on the use of all-covalent 3D networks obtained by interconnecting AuNPs with dithiolated crown ethers which act as molecular linkers. In the present case, we have performed the layer-by-layer assembly of AuNPs mediated by dithiolated crown ethers on a substrate with photolitographically patterned electrodes. The ion adsorption/desorption into the AuNP-based network is pivotal for the final performance. Such interaction can determine a modification of the network's structure (e.g. via swelling) or electronic properties (e.g. via a change in the device resistance). The performance of such devices was studied and optimized in terms of NPs size as well as the geometry of the gold interdigitated electrodes. Finally, to demonstrate the sensing capabilities of these hybrid nanocomposites we have performed the real time detection of potassium ions (K^+) in water.
The ultimate goal is to develop a technology that can be implemented in portable optoelectronic devices, whose performance can compete with state-of-art devices within this field of interest.

References

[1] J. Liao, et al., Chem. Soc. Rev.,44 (2015), 999
[2] K. Saha, et al., Chem. Rev.,112 (2012), 2739
[3] R. Pinalli, et al., Chem. Soc. Rev., 47 (2018),7006