Chemically functionalized low-dimensional nanostructures for chemical sensing

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Low-dimensional materials (LDMs) with high surface-to-volume ratios serve as sensitive elements in chemical sensing applications. They enable enhanced responsiveness, sensitivity, and reversibility, with low limits of detection. However, the primary shortcoming is the lack of selectivity of several LDMs towards the analyte of interest, since the interaction between the two components is intrinsically unspecific. Fortunately, this constraint can be addressed through chemical means. Achieving fine selectivity involves modifying LDMs with suitable (supra)molecular receptors capable of recognizing target species, via one or multiple non-covalent interactions.[1]
In my lecture, I will present our recent findings on the functionalization of gold nanoparticles (AuNPs) to engineer hybrid systems suitable for various chemical sensing applications.
On the one hand, I will present a work focused on developing chemiresistors (CRs) using three dimensional (3D) networks of AuNPs bridged by supramolecular receptors (dithiomethylene dibenzo-18-crown-6 ether, DTDB-18C6) for potassium ions (K^+) sensing. These CRs demonstrate linear sensitivity, high selectivity, stability, reversibility, fast response time, and compatibility with microfluidic systems, making them promising for point-of-care (POC) sensing, particularly in health monitoring.[2]
On the other hand, I will present a rapid and highly sensitive colorimetric approach for detecting transition metal ions (Fe^{3+}, Cu^{2+}, Ni^{2+}) in toluene-acetonitrile mixtures using Schiff-based functionalized AuNPs. Detection limits for all three metal ions were at least two orders of magnitude lower than EU recommended limits, with successful application demonstrated in assessing nickel levels in industrial waste.[3]
Overall, the presented strategies highlight that the exploration of novel functionalization strategies for gold nanoparticles or other LDMs could lead to the development of hybrid systems with improved performance and versatility for sensing various analytes. These developments hold promise for advancing point-of-care diagnostics and environmental monitoring, contributing to improved healthcare and sustainability efforts.

References

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Figure

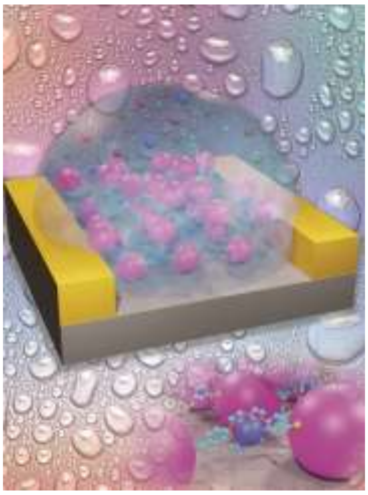

Figure 1. Chemiresistor based on covalently assembled Au NPs-DTDB-18C6 networks.