Synergistic opto-electrochemical dual transduction for advanced biosensing

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Conventional biosensors typically rely on a single transduction mode, either optical or electrochemical, and face multiple challenges to detect and quantify trace biomarkers in noninvasive body fluids like sweat, tears, and saliva. This is due to the presence of extremely low concentration of analytes, which requires advanced biosensing technology with high sensitivity and selectivity. Atomically precise metal nanoclusters (NCs) are the ultrasmall assemblies (< 2 nm) of few metal atoms, encapsulated by organic ligands. [1] Such ultrasmall NCs in conjugation with two-dimensional (2D) inorganic nanosheets (NSs) could serve as a foundational scaffold, enhancing light-matter interactions and functionality. [2] In this study, we present a dual-mode concept of light-driven photo-induced electrochemical approach by combining gold NCs with conductive 2D NSs. Strong interfacial bonding and charge transfer between NCs and the 2D scaffold reorganize local electronic states, establishing an efficient pathway for carrier separation under illumination. Photoexcited NCs upon interaction with analytes could directly oxidize the molecules by their photogenerated holes, while the conductive NSs extract and transport the photoelectrons to the electrode, suppressing recombination and amplifying the signal (Figure 1). Such a hybrid platform delivers rapid, reversible on/off responses with low background, quantitative signals across broad concentration ranges, and robust selectivity against common interferents.

Keywords:
Gold nanoclusters, 2D nanosheets, Charge transfer, Biosensing

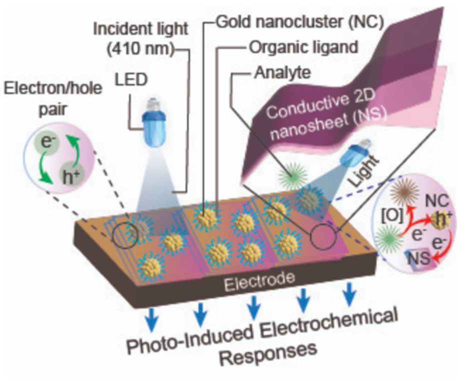

Figure 1. Schematic representation for the generation of photo-induced electrochemical responses.

References:

[1] R. Jin et al., *Chem. Rev.* 2016, **116** , 18, 10346.
[2] Q. Li. et al., *Chem. Rev.* 2024, **124** , 9, 5695.

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