Metal–Graphene Hybrid Nanostructures as a Platform for Label-Free Refractive Index Sensing

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Metal–graphene hybrid nanostructures have emerged as a versatile platform for label-free refractive index (RI) sensing, combining strong electromagnetic field confinement in metallic plasmonic elements with the surface sensitivity and electronic response of graphene [1]. In such hybrid systems, plasmonic modes arise from the electromagnetic interplay between metallic resonators and nearby graphene layers, enabling tailored localization of optical fields at the sensing interface. The incorporation of graphene alters the local dielectric environment and charge carrier dynamics, enhancing light–matter interaction without enforcing a single dominant plasmonic mechanism [2].

Here, we examine hybrid architectures in which surface plasmon polaritons (SPPs) supported by metal–dielectric interfaces are influenced by the presence of graphene through proximity-induced coupling. The resulting resonances show pronounced sensitivity to variations in the surrounding refractive index, driven by hybrid mode formation, field redistribution, and increased interaction with the analyte region. This highlights metal–graphene hybrids as a unified framework for RI sensing across diverse plasmonic regimes.

References

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[2] Z. Fei, A. S. Rodin, G. O. Andreev et al., Nature, 487 (2012) 82–85