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Biopolymer-Templated Deposition of Hierarchical 3D-Structured Graphene Oxide/Gold Nanoparticle Hybrids for Surface-Enhanced Raman Scattering

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Cellulose, a well-known natural biopolymer, possesses numerous advantages such as cost-effectiveness, renewability, ease of processing, and biodegradability [1]. Due to these inherent merits, cellulose has emerged as a promising bio-based substrate capable of synergistically combining with conductive materials (e.g., metals or carbon-based materials) for diverse applications including sensors, smart windows, and bioelectronics [2]. Typically, surface-enhanced Raman scattering (SERS), an advantageous analytical technique, allows for the rapid detection and structural analysis of biological and chemical compounds through their spectral patterns in nanotechnology [3]. Crucial for SERS is fabricating the substrates with strong and reproducible enhancements of the Raman signal over large areas and with a low fabrication cost. Herein, we present a straightforward approach utilizing the layer-by-layer spray coating method to fabricate (CNF) films loaded with gold nanoparticles (AuNPs) and graphene oxide (GO) to serve as SERS substrates. To investigate the fundamental mechanisms of enhanced SERS performance, grazing incidence small-angle X-ray scattering (GISAXS) technique combined with the machine learning random forest method is employed to identify different nanostructures for predicting vibrational frequencies and Raman intensities. Therefore, our approach provides a reference for facile and scalable production of universally adaptable SERS substrates with exceptional sensitivity.

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