

Surface-Enhanced Raman Spectroscopy for Biological Systems: *A New Class of Frenkel Excitonic SERS-Active Nanoassemblies*

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Raman spectroscopy is a powerful analytical technique for studying biological systems, but it is limited by inherently weak intensity of Raman scattering. Surface-enhanced Raman spectroscopy (SERS) can substantially improve signal intensity; however, conventional plasmon-based SERS-active materials often depend on uncontrolled nanoparticle aggregation, leading to poor reproducibility, and show limited stability and compatibility in aqueous biological environments. Here, we present Frenkel excitonic supramolecular Cyanine-Arginine NanoAssemblies (eCYANAs), a highly homogeneous, aqueous-compatible, non-plasmonic SERS-active nanomaterial for biological systems [1-2].

As a proof of concept, we evaluated the potential of eCYANAs for cellular SERS measurements by incubating them with triple-negative breast cancer cells (TNBC), which revealed distinct cell-associated Raman bands that were absent from eCYANAs alone. These spectral features were consistent with biomolecular components including lipids, proteins, and nucleic acids, demonstrating the ability of eCYANAs to probe cellular biochemical signatures. To further improve cellular SERS measurements, we developed a polydimethylsiloxane (PDMS) and calcium fluoride (CaF₂) platform optimized for low-background SERS measurements by minimizing substrate-derived spectral interference [3]. TNBC cells successfully attached to the CaF₂ surface and remained viable following eCYANA treatment, establishing a suitable platform for subsequent collection of cell-derived SERS spectra. Together, these findings demonstrate the potential of eCYANAs as a highly homogeneous, non-plasmonic SERS-active material for cellular biomolecular fingerprinting.

REFERENCES

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