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Label-free nanoscale investigation of bio (-compatible) materials

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Tip-enhanced Raman scattering (TERS) has emerged as a powerful technique for exploring biomaterials at nanometer resolution. It provides chemically specific, label-free imaging beyond the optical diffraction limit. It is especially advantageous when labels cannot be used, a main requirement for super-resolution fluorescence methods, which rely on fluorescent labeling. TERS provides direct molecular fingerprinting with spatial resolution well below 10 nm, without the need for exogenous labels.
We will demonstrate the distinct advantages of TERS for selected biomaterial applications. Initially we will demonstrate a TERS enabled the direct localization of a chemotherapeutic agent that intercalates within isolated double-stranded DNA. Here and additional labelling would clearly interact either with the ds DNA or with the drug, both interactions cannot be ignored and would certainly affect the experiment. The TERS results here reveal a specific drug–nucleobase interactions and also identify unique intercalation markers that simplify follow-up studies. Such chemical specificity at the single-molecule level is unattainable with conventional fluorescence-based approaches, which cannot differentiate between chemical states or binding modes.
In a second investigation, the integration of TERS with atomic force microscopy (AFM) techniques has been employed to investigate the molecular organization of block copolymer nano particles as models for drug delivery systems. TERS mapping elucidated the presence of ordered peptide conformations at the hydrophilic/hydrophobic interface. The correlated mechanical information provides directly information regarding the elasticity and adhesion of the nano particles, providing a direct correlation of structure and property at the nanometer scale.
Together, these studies underscore the power of TERS as a high-resolution, chemically specific technique for probing heterogeneous biomaterials. The combination with nano-mechanical experiments not only provides direct structure-property relations but also provides a fast pre-screening method to locate sites for extensive near-field spectroscopy.

Scholarship elegibility

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