RamanFest Frankfurt | GERMANY July 02-03 2025

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Synergetic TERS on Polymer Nanoparticles

Tip-enhanced Raman scattering (TERS) has emerged as a transformative nano spectroscopic technique, uniquely combining chemical specificity with nanometer-scale spatial resolution. When integrated with scanning probe-based techniques, TERS enables direct correlations between chemical composition and nanomechanical, structural, or electronic properties. This synergistic approach can provide locally correlated information on the structure-property relationship of the investigated surface.
Here, we explore synergistic TERS methodologies applied to polymeric nanoparticles relevant for drug delivery. In one example, the incorporation of short β-sheet-forming peptide domains into amphiphilic block copolymers changes the micelles contour lengths and stiffness. Through TERS mapping of the polymer interface, the β-sheet structures were identified and correlated to the nanomechanical properties observed in AFM nanoindentation experiments.
In a second system, reversibly crosslinked micelles were AFM-studied under aqueous conditions. The AFM-based mechanical measurements were paired with TERS chemical mapping on fixed and sliced nanoparticles to assess changes in elasticity upon core (de-)crosslinking. This correlation enables of a molecular-level understanding of of the mechanical stability and the structural composition. This information can be used for the optimization of drug release properties.
In addition to the utilization of TERS-based multimodal analysis in discrete applications, the present study emphasizes the broader potential of this approach. In contrast to fluorescence-based super-resolution techniques, TERS provides label-free, chemically resolved surface-sensitive data. When integrated with further techniques such as nano-IR, STM, or micro-Raman, synergistic TERS has been shown to be capable of resolving surface versus bulk characteristics in a qualitative and quantitative manner. Consequently, this approach facilitates the rational design of nanomaterials with targeted mechanical, electrical, or biological function.

References

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