

## 量子物理学・ナノサイエンス第 439 回セミナー

# Material Characterization at the Nanoscale via Plasmon-Enhanced Nanospectroscopy & Sensing

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## 概要

The realization of optical microscopy capable of true nanoscale observation has long been a central goal in science and engineering. With the rapid development of nanomaterials and nanodevices in recent years, analytical techniques that can address increasing structural and functional complexity have become essential. In this context, optical microscopy offers unique advantages, including operation under ambient conditions without the need for cryogenic temperatures or high vacuum, as well as non-contact and non-invasive measurement capabilities.

Our research focuses on the development of advanced nanospectroscopy and sensing methodologies based on plasmonic resonances. The key advantages of plasmonic systems arise from two fundamental properties: the strong enhancement and the extreme localization of electromagnetic fields. These properties are critical for nanoscale measurements, as field localization improves spatial resolution, while field enhancement compensates for inherently weak signals originating from small volumes of material or limited numbers of molecules.

Plasmonic resonances can be broadly classified into two categories: (1) localized surface plasmon resonance (LSPR) and (2) propagating surface plasmon resonance (SPR). In this presentation, I will introduce representative nanospectroscopic techniques based on LSPR, such as tip-enhanced Raman spectroscopy (TERS), as well as sensing approaches based on SPR, including Goos-Hänchen and Imbert-Fedorov shifts (GHS and IFS) and the photonic spin Hall effect (PSHE).

Particular emphasis will be placed on the extension of these techniques to diverse experimental environments, enabling broader applicability to a wide range of target materials. Furthermore, beyond the pursuit of high spatial resolution, recent efforts toward achieving high temporal resolution and rapid sensing—particularly through terahertz (THz) spectroscopy—will also be discussed.

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