REVEALING CHEMICAL AND PHYSICAL PROPERTIES AT THE NANOSCALE

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Nanomaterials play a crucial role in various fields such as biomedicine, energy, composites, and catalysis. Understanding their properties at the nanoscale is essential for optimizing their applications. However, traditional bulk analysis methods fall short in providing detailed information on size, shape, and local chemical composition. In this presentation, we will explore the combination of scanning probe microscopy and optical spectroscopy techniques to obtain chemical insights at the nanoscale. We will begin with an in-depth discussion of tip-enhanced Raman spectroscopy (TERS), a powerful method based on Raman spectroscopy. TERS utilizes plasmonic nanoprobes integrated with atomic force microscopy (AFM) to achieve nanoscale resolution. We will delve into the working principles, limitations, and showcase examples of its application in different nanomaterials. Additionally, we will introduce two other promising methods: nano-vis, which measures thermal expansion using AFM under modulated optical excitation, and scanning electrochemical microscopy (SECM), which maps electrochemical activity using a nanoscale electrode tip. Collectively, these techniques offer unprecedented spatial resolution and provide valuable insights into the chemical and physical properties of nanomaterials.

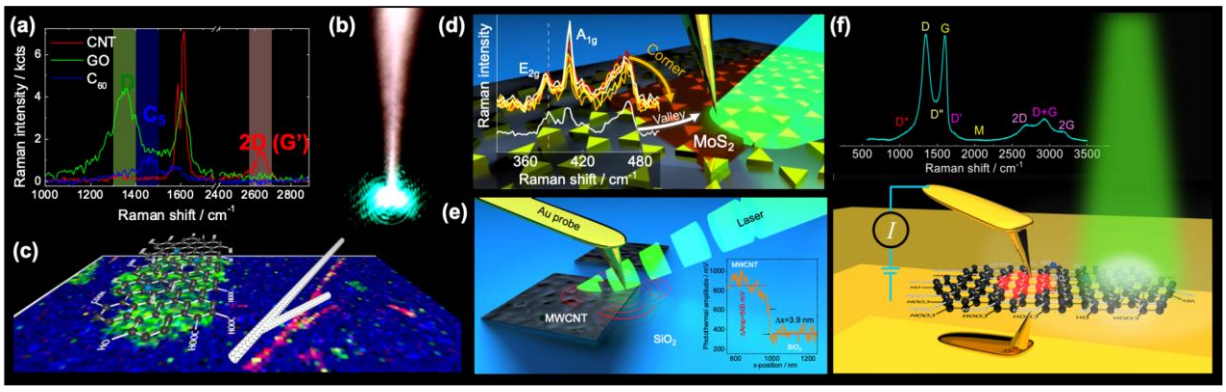

Fig. 1. (a) Tip-enhanced Raman spectroscopy (TERS) enables nanoscale chemical analysis. (b) Plasmonic tips enhance Raman signals for improved spectroscopic measurements. (c) Nanoscale resolution optical spectroscopy maps are achievable with TERS. (d) AFM and optics integration enables measurement of physical parameters such as strain. (e) Photothermal expansion can be studied at the nanoscale using AFM-optical techniques. (f) AFM provides not only topographical information but also valuable optoelectronic properties when combined with an optical system.

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