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Scanning Raman Picoscopy: a new technique that can visually determine the chemical structure of a single molecule

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Abstract

The determination of the chemical structure of a molecule is of paramount importance in any molecule-related science, critical for understanding its chemical, physical, and biological functions. Scanning tunneling microscopy (STM) and atomic force microscopy (AFM) have shown a remarkable ability to visualize molecular skeletons, but still lacking sufficient chemical information for precise chemical structure determinations. The ability to achieve single-molecule Raman mapping with sub-nanometer spatial resolution (~ 0.5 nm) provides a powerful means to chemically resolving the internal structure of a molecule [1]. It has been shown that such high resolution Raman images are resulted from the spatial confinement of nanocavity plasmon[2-3]. It was predicted that with Ångström resolution, the Raman images of individual vibrational modes of a molecule in real space could be obtained [4], which was verified by a recent experimental work [5]. Very recently, the full images of individual vibrational modes have been experimentally produced, which enables us to visually construct the molecular chemical structure through a Lego-like building process [6]. This marks the birth of a new methodology, named as scanning Raman picoscopy (SRP), for molecular structure determinations. A new opto-magnetic effect related to SRP [7] will also be discussed.

Keywords: Nanocavity Plasmon, Vibrational Images, Opto-Magnetic Effect

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