先端増強ラマン散乱顕微鏡：分解能と増強度
Tip-enhanced Raman Scattering Microscopy: Resolution and Enhancement

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Raman scattering microscopy has become one of the hot topics in microscopy community as a tool for analyzing advanced nano-materials, such as biomolecules in a live cell, semiconductor devices for characterizing strain distribution and contamination, nano-carbons and 2D nano-materials [1]. However, the cross-section of Raman scattering at molecules is extremely small compared to fluorescence or infrared absorption, and the spatial resolution is limited due to the diffraction. In this presentation, I would like to discuss the spatial resolution and scattering enhancement of Raman scattering microscopy. Scattering efficiency is enhanced either by coherent nonlinear Raman scattering process, plasmonic field enhancement mechanism, or non-resonant Raman scattering process [2]. Even line-illumination microscopy with a polychromator and a 2D-CCD effectively reduces the time of exposure for spontaneous Raman scattering imaging [3]. In the tip-enhanced scattering (TERS) microscope, a metallic probe tip enhances the field typically by the factor of typically 10^3 to 10^6, due to the resonance of surface plasmon polaritons in the antenna geometry [4]. Spatial resolution is also enhanced by the factor of typically 10 to 20 beyond the classical diffraction limit by the localization of plasmons at the tip [5]. Deep UV laser excitation makes scattering efficiency much higher, typically x10^8, than visible/near-infrared excitation due to the resonance Raman scattering, for nucleotides and proteins in a cell, and photo-degradation of molecules is effectively suppressed due to the energy transferring from bio-molecules to lanthanide ions doped in solution [6]. Aluminum was used as plasmonic materials for the tip in deep UV [7], and liquid-immersion objective was developed based on Schwarzschild design with NA of 0.9 [3]. If time allows I would like to extend my talk to the further issues, 1-nm resolution [8], 3D imaging in a living cell [9], and non-scanning TERS imaging [10].

References

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