Project Title:

FINITE ELEMENT SIMULATIONS OF TIP-ENHANCED RAMAN SPECTROSCOPY AND MICROSCOPY

Name : ALVARADO B. TARUN
Affiliation: Nanophotonics Laboratory Advanced Science Institute Wako Instutite

We perform simulation to predict the optimum conditions (tip size and geometry, optical property of samples and tip, experimental configurations, etc) for obtaining higher field enhancement that is for tip-enhanced Raman and fluorescence imaging of various samples in air and aqueous environments. We will also study the possibility of high-speed imaging for samples under high temperature and high bias conditions at different light polarization.

Due to the growing number of applications of TERS, much work has been devoted to the development of new techniques to obtain high-contrast and high-resolution TERS signals. Signal-to-noise-ratio (SNR) degradation in near-field (NF) detection is mainly due to the FF background signal generated at the diffraction limited focus spot introduced by external illumination optics. . In this work, we will optimize all the parameters needed to obtain high near field signal in TERS. We have introduce a thermally assisted tip-enhanced Raman spectroscopy using the heat generated from the enhanced electromagnetic field at the tip apex that is transferred to the sample by conduction and radiation. This technique can used to characterize various materials where a nanometer-sized heat source of variable temperature range is required. The other contribution we wanted to check is effect of polarization and bias voltage on the sensitivity of TERS. In this technique, we will apply bias voltage between the tip and sample and determine the effect on the sensitivity of TERS measurement. This bias effect will be investigated at different incident polarization of light. We make a distinction between the FF background signal and the NF signal by spectrally resolving the Raman shifted peak and broadened linewidth coupled with the amount of bias voltage and state of light polarization generated from the tip enhancement. The models that will be developed will be very useful in the field of basic physical research related to electro-optical and thermo-mechanical near field studies.

I will be using Finite Element Method (ANSYS Multiphysics). The research require 3D model, which will make the calculation a bit longer (30mins/job).

Fiscal Year 2010 List of Publications Resulting from the Use of RICC

[Publication]

1. A. Tarun, N Hayazawa, T. Yano, and S. Kawata, "Tip-heating-assisted Raman spectroscopy at elevated temperatures", J. Raman Spectrosc. DOI: 10.1002/jrs.2820 (2010).

2. A. Tarun, N Hayazawa, and S. Kawata, "Site-Selective Cutting of Carbon Nanotubes by Laser Heated Silicon Tip", Jpn. J. Appl. Phys. 49, 025003 (2010).

[Oral presentation at an international symposium]

A. Tarun, N. Hayazawa, T. Yano, and S. Kawata, "Tip-heating assisted manipulation and nano-Raman spectroscopy of Carbon Nanotubes," Near Field Optics - NFO 11 (Beijing, China, August 31, 2010).

A. Tarun, N. Hayazawa, and S. Kawata, "Tip-heating assisted TERS at elevated temperature ," XX11 International Conference on Raman Spectroscopy (Boston, USA, August 12, 2010).