Near-field absorption imaging by two color nano-light source

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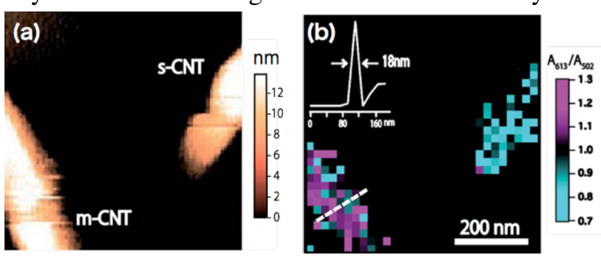
Aperture-less near-field scanning optical microscopy (NSOM) is a promising technique for nano-scale imaging which provides high spatial resolution beyond the diffraction limit of light. In an ordinary NSOM with visible light such as tip-enhanced Raman spectroscopy (TERS), the apex of a metallic tip is illuminated to excite the locallized surface plasmon, which generates near-field scattering from a sample. As a result, one can obtain physical and chemical properties of the sample at nano-scale. However, the major problem in an ordinary NSOM is background signal of the sample generated by the incident laser, which deteriorates the detection sensitivity significantly. This background signal, which is at the same wavelength as the near-field signal, adds up to the near-field signal and worsens the detection quality.

In this study, we utilized an uncoated silicon nano-tip as the near-field probe for NSOM, which creates a strong Raman signal of silicon at the tip apex [1]. The wavelength of this Raman signal is shifted to 520 cm^{-1} from the excitation wavelength, so that the background is spectrally separated from the signal. When the nano-tip is placed on the sample and is illuminated, silicon Raman signal can be partially absorbed by the sample while passing through it. Since the silicon Raman light is highly confined at the only tip apex, this absorption occurs only in near-field. Thus, one can measure the near-field absorption of the silicon Raman signal by monitoring the intensity of transmitted light through the sample. Since the total amount of absorption is dependent on sample topography as well as absorption coefficient of the sample, it is required to remove the effect of sample thickness from absorption measurements. For this purpose, we employed two excitation lasers with wavelengths of 488 nm and 594 nm, to observe the inherent optical properties of the sample independent of the sample topography [2]. We took the absorption ratio between two Raman signals of silicon excited by two different wavelengths, which allowed the contribution of sample topography to be neglected. Figure (a) shows an AFM image of metallic and semiconducting CNTs. We obtained an absorbance ratio image (Fig-b) constructed by the intensity ratio of Raman signals of silicon excited by the two lasers, which reflects absorption coefficient of the sample and allows us to distinguish the two kinds of CNTs, due to the difference of their absorption coefficients.



(a) An AFM image of two types of CNTs (b) An absorbance ratio (A_{613nm}/A_{502nm}). The inset shows a line-profile of absorbance ratio along the white dotted line.

References

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