RAMAN FREQUENCY VARIATION UPON EXCITATION WAVELENGTHS FOR ZnO NPS

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Abstract: We have found that LO and TO modes in polar and nonpolar semiconducting materials have distinct physical origins. Here we use Raman Spectroscopy excited by laser light of various wavelengths to study the frequency variations of LO and TO modes in polarized semiconducting material ZnO NPs.

ZnO is a semiconducting compound with a broad band gap of 3.36eV at room temperature, which has been widely used in various optical-electrical devices [1]. Raman scattering is a convenient tool which can provide us with plenty of information about crystal structure and elementary excitons. In this report we are going to analyse Raman frequency dependence on different excitation wavelengths for ZnO NPs.

From the TEM images, we estimated that the average diameter of our sample ZnO NP is about 5-7nm. The Raman spectra were collected on a Renishaw 1000 Micro Raman spectrometer and a Fourier Raman spectrophotometer (Spectrum GX FT-IR System) in the back-scattering geometry at room temperature.

Figure 1 and 2 show the first order experimental Raman spectra of ZnO Bulk-powder (BP) and –NPs excited by 514.5nm laser line, respectively. The first order Raman modes $A_{1\text{T}}, E_{1\text{T}}, E_{2}(\text{H}),A_{1\text{L}}$, and $E_{1\text{L}}$ are identified as the peaks at: 385, 426, 437, 572 and 584 cm\textsuperscript{-1}.

Raman spectrum of ZnO NPs at different excitation wavelengths is shown in Fig 3. The variations of frequency with excitation wavelengths are shown in Fig 4. From Fig 3, we can see that the peak positions of all modes remain nearly unchanged with different excitation wavelengths,
which is different from that observed in carbon nano-tubes [2] and Si nano-wires [3].

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\text{Figure 3: Raman spectra of ZnO NP at different excitation wavelength}
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\text{Fig. 4 Dependence of Raman frequency on excitation wavelengths}
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The result shown in Fig 4 indicated that the size confinement effect on Raman frequency shift with the excitation wavelength [2, 3] does not occur. We may explain this ‘abnormal’ phenomenon reasonably, if we note that the first order Raman spectra of polar nano-scale semiconductors is correlated with its phonon density of states and the phonon density of states is irrelative with the size of samples.

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