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Surface enhanced resonance Raman scattering from radial and tangential modes of semiconducting single wall carbon nanotubes

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Abstract

Surface enhanced resonance Raman scattering experiments have been carried out on semiconducting single wall carbon nanotubes (SWNTs) adsorbed on mechanically polished rough silver foils. Stokes (S) and anti-Stokes (AS) spectra of both the tangential and the radial modes are studied as a function of incident laser power. This yields the estimation of surface enhanced Raman scattering cross-section using vibrational pumping model. Results are compared with the earlier reports.

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Keywords: Surface enhanced; Raman scattering; Nanotubes; Tangential mode; Radial mode

1. Introduction

Single wall carbon nanotubes (SWNTs) are fascinating nanosystems exhibiting remarkable physical properties like one-dimensional conduction, tunability between semiconducting and metallic states [1], electric field induced field emission [2–5] and remarkable mechanical resilience [6–10] making them good candidates for flexible nanoropes. Apart from basic physics point of view, SWNTs are also being explored to be used in novel applications like actuators [11], pressure sensors [12], flow sensors [13], nanoscale electronics [14] and hydrogen storage [15].

Among all these interesting properties that SWNTs possess, their vibrational and electronic properties have been widely studied in recent years. Resonance Raman scattering has proved to be a very sensitive probe to study these properties [16]. Very recently, it was shown [17–21] that the Raman signal of the nanotubes gets enhanced by many orders of magnitude when adsorbed on rough metallic surfaces, exhibiting the well known surface enhanced Raman effect for organic molecules [22–24]. SERS experiments performed in resonance conditions select a single class of SWNTs, i.e. semiconducting or metallic thereby helping to make an unambiguous assignment of the vibrational modes. It also provides exciting possibilities to study Raman spectrum of a single nanotube [18]. SERS experiments have been done on rough silver/gold surfaces prepared by evaporation [20] or by

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