Laser heating control with polarized light in isolated multi-walled carbon nanotubes

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Abstract

We are proposing a novel method of laser heating control only through change in polarization of the incident light, keeping its power density constant [1]. The idea combines antenna effect found in isolated multi-walled carbon nanotubes and the possibility of their heating by light illumination. To observe this we used Raman spectroscopy technique (see fig. 1), where the heating manifests itself in a pronounced downshift of the Raman G and 2D lines as a function of the polarization angle (see fig. 2). To our knowledge, this is the first
experimental demonstration of polarization dependent heating effect in carbon nanotubes probed by Raman spectroscopy or by any other technique. Interpretation of the observed phenomena will be discussed.
Our method can be useful in field electron emission devices or in selective nanotubes heating and destruction. It can also be extended to other one dimensional nanoobjects, if only certain conditions are fulfilled. We expect that the effect presented here can be found in other high aspect ratio nano-objects, if only localization of the electronic states is high enough and/or they stay within the electrostatic limit.

References

[1] M. Zdrojek, J. Judek, M. Wąsik, Phys. Rev. Let. **108**, 225501 (2012)

Figures

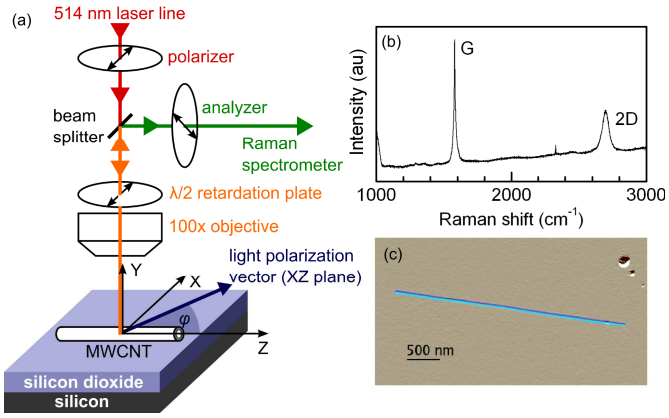

Fig. 1 (a) Schematic of the experimental setup used for exploring the dependence of the inelastic scattering amplitude and phonon energy on the angle φ between the carbon nanotube axis and the direction of the electric field vector of the incident and scattered light. (b) Raman spectrum from an isolated multiwalled nanotube.(c) Atomic force microscopy image of isolated MWCNT (d~ 30 nm) on the SiO_2/Si substrate.

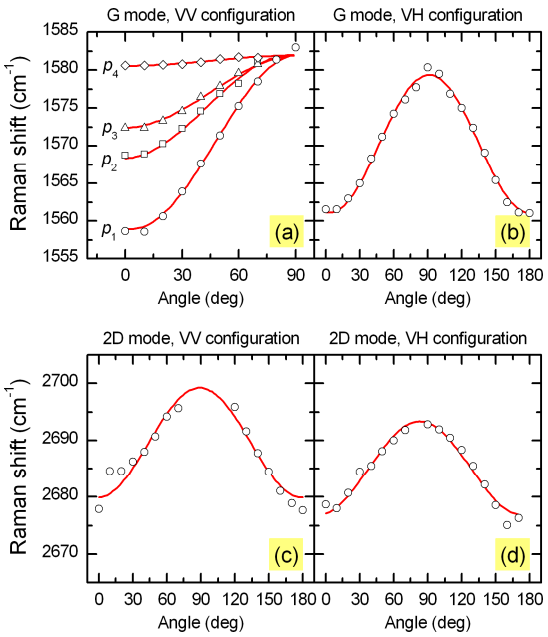

Fig. 2 Angular evolution of G and 2D band positions for two polarization configurations (VV and VH). Four data series in a plot (a) acquired for the different laser power densities ($p_1 > p_2 > p_3 > p_4$) prove the thermal origin of the Raman shift change. Experimental data (open symbols) were fitted with the $\cos^2(\varphi)$ function (lines).