INTERBAND MAGNETO-OPTICAL STUDIES OF SINGLE-WALLED CARBON NANOTUBES IN HIGH DC MAGNETIC FIELDS UP TO 45 T

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Introduction

The band structure of a single-walled carbon nanotube (SWNT) is predicted to depend on the Aharonov-Bohm (AB) phase $2\pi\phi/\phi_0$ (ϕ_0: magnetic flux quantum). Consequences are expected to appear in interband optical spectra as peak shifts and splittings. Here we report the first magneto-optical study on SWNTs, revealing the predicted peaks shifts and splittings [1].

Experimental

The nanotube solution was contained in a quartz cell, mounted with a polarizer on a specially designed sample stick with integrated optic fibers, lenses, and mirrors. All measurements were done at room temperature.

Results and Discussion

Figure 1(a) shows polarization-dependent absorption in the Voigt geometry. The solid (dashed) lines are for parallel (perpendicular) polarization. The field induces optical anisotropy. Also, each peak broadens with *B* [Fig. 1(b)]. Figure 1(c) shows PL spectra up to 45 T. All peaks shift to lower energy, and the shift is more obvious for lower energy peaks.

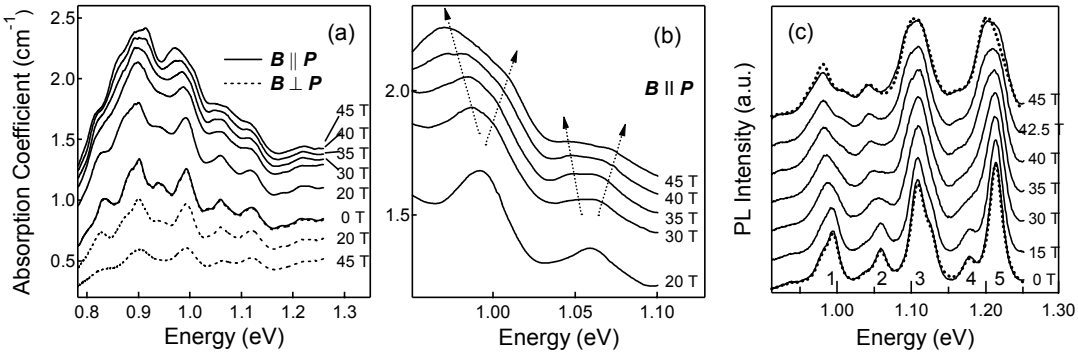

Figure 1 (a) Polarization-dependent absorption spectra. Solid (dashed) lines are for parallel (perpendicular) polarization. No traces are offset. (b) Expanded plot for the *B*//*P* case from 20 T to 45 T. (c) PL spectra. Solid (dashed) lines correspond to measured (fitted) data. The chiralities of the dominant peaks are 1: (10,3), 2: (8,6), 3: (7,6), 4: (10,2), 5: (7,5).

These data can be explained in terms of the AB-effect-induced splitting and magnetic alignment of tubes. The obtained values for 45 T splitting are comparable to the predicted values, and an order of magnitude larger than the Zeeman splitting.

Conclusions

We have performed magneto-optical experiments on SWNTs up to 45 T, confirming theoretical predictions that the band structure of a SWNT is dependent on the magnetic flux, ϕ, threading the tube.

Acknowledgements

This work was supported by the Robert A. Welch Foundation (No. C-1509), the Texas Advanced Technology Program (No. 003604-0001-2001), and the National Science Foundation (No. DMR-0134058).

References

[1] Zaric, S., *et al*., Science, **304**, 1129-1131 (2004); Nano Lett., **4**, 2219-2221 (2004).