

UV absorption control of SWNT films by modulation of perpendicular π plasmon excitation

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Abstract:

Recently, we have found that the remarkable UV absorption of SWNTs that had been conventionally explained as π plasmon excitation is actually composed of two distinct components at ~ 4.5 and ~ 5.2 eV and that these peaks exhibit different dependencies on incident light polarization [1]. We have discussed the origins of these UV absorptions and concluded that the former (~ 4.5 eV) is $\pi \rightarrow \pi^*$ interband transition excited by polarized light parallel to SWNT axis whereas the latter (~ 5.2 eV) is π plasmon excited by perpendicularly polarized light [1]. Such a consideration implies that only the latter (~ 5.2 eV) can be controlled by a modulation of chemical potential of SWNTs, for the collective plasmon excitation is a Fermi-surface related phenomenon. In order to confirm our conclusion above, we performed an electro-chemical experiment using our vertically aligned SWNT film grown on a quartz substrate [2] that is set in acetonitrile dissolved with 0.1 M LiClO₄ as an electrolyte. Figure 1 shows optical absorption spectra measured with the voltage changing 0 \rightarrow +800 mV (left) and subsequently +800 \rightarrow 0 mV (right panel). In our system, +800 mV is an upper limit for ensuring the reversibility against the separation of the electrolyte. In addition to known inter-subband absorption below 3 eV, the simultaneous change of UV absorption around 5.1 eV is clearly observed. This result not only provides a direct evidence to above discussion (i.e. ~ 5.2 eV peak is plasmon while that at ~ 4.5 eV is not), but also shows a way of controlling UV absorption of SWNTs, which would be more efficiently fulfilled if a dry-processed gate electrode is used to achieve an applied voltage of as high as several volts.

[1] Y. Murakami et al., Phys. Rev. Lett. **94** (2005) 087402. [2] Y. Murakami et al., Chem. Phys. Lett. **385** (2004) 298.

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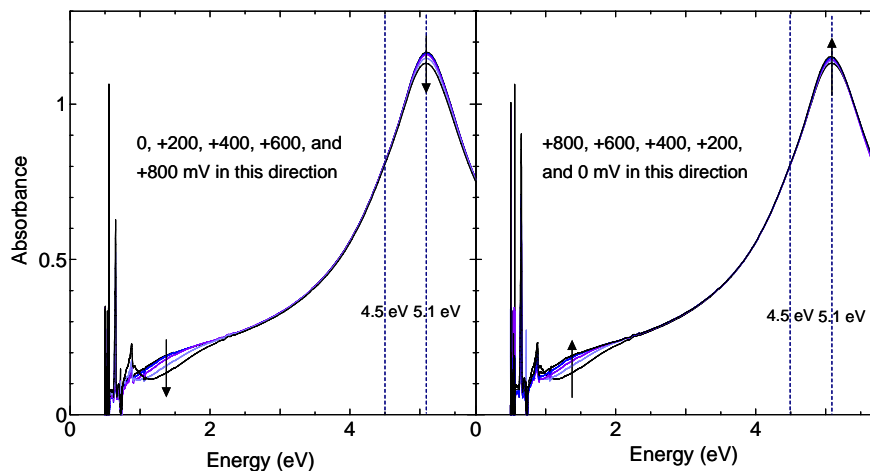


Fig. 1. Optical absorption spectra of a VA-SWNT film measured in acetonitrile with 0.1 M LiClO₄. The applied voltage is varied as 0 \rightarrow +800 mV (left) and subsequently +800 \rightarrow 0 mV (right panel).