# nIR fluorescence properties of functionalized carbon nanotubes

F. Mann, S. Kruss, Institute of Physical Chemistry, Göttingen University, Germany (September 2018)

## Application Note

### Introduction

Nanostructured carbon nanomaterials have gained a lot of interest in the last years. Especially the unique optoelectronic properties of single-walled carbon nanotubes (SWCNTs) such as their excitonic fluorescence (see Fig. 1) in the near-infrared (nIR) region have attracted a lot of interest. These properties make SWCNT versatile building blocks for applications in biosensing, imaging and even drug delivery or photodynamic therapy.[1]

### Results

Fig. 2 shows the absorption and fluorescence spectra of DNA-wrapped carbon nanotubes. In this particular study we tested the sensing capabilities of these special SWCNT-DNA conjugates for the neurotransmitter dopamine and the competitive selectivity for its structural analogues epinephrine and norepinephrine. The spectra in the range between 800 nm – 1200 nm clearly show that the $(GT)_{10}$ DNA sequence leads to a high fluorescence increase for dopamine, whereas

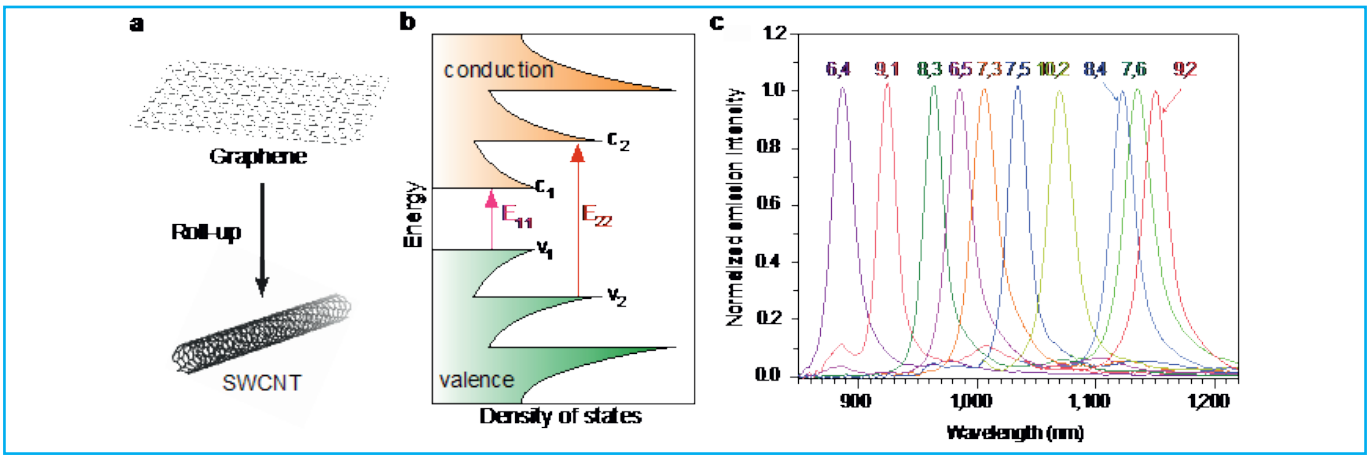


Figure 1, (a) Single-walled carbon nanotubes (SWCNT) can be considered as rolled up sheets of graphene. (b) Density of electronic states diagram of semiconducting SWCNTs and transitions E11 and E22 between van-Hove singularities leading to different absorbance and fluorescence spectra depending on the chiral index (m,n). (c) nIR fluorescence spectra of SWCNTs of different chirality (n,m) [1],[2].

We are interested in using SWCNTs as near-infrared optical sensors to detect biomolecules[1-3]. These sensors are powerful tools e.g. to image release of neurotransmitters from cells[4]. To be able to use these highly hydrophobic nanomaterial for the sensing of (bio)molecules functionalization of their surface is crucial[5]. This is commonly achieved via ultrasonic "wrapping" with small synthetic DNA sequences. Recently, we also showed, that it is possible to use barrel-forming peptides to achieve a colloidal aqueous solution of SWCNTs[6].

### Experimental set-up

To characterize these functionalized SWCNTs we routinely employ near-infrared (nIR) fluorescence spectroscopy using the Kymera-193i-B2 spectrograph equipped with an iDus InGaAs DU491A-1.7 nIR detector array. Samples are excited with a Cobolt 561 nm laser.

(nor-)epinephrine only induces a slight increase. Thus, these sensors can be used for the detection of dopamine in the presence of equimolar amounts of epinephrine or norepinephrine.[4]

### Summary

We successfully used the Kymera-193i spectrograph and the iDus InGaAs 491 nIR detector to acquire nIR fluorescence spectra of functionalized carbon nanotubes [5-8]. They act as sensors for biomolecules and we quantified quantum yield changes after the addition of neurotransmitters. These findings lead to a better understanding of carbon nanotube photophysics and sensors of high selectivity/sensitivity for promising biomedical applications.

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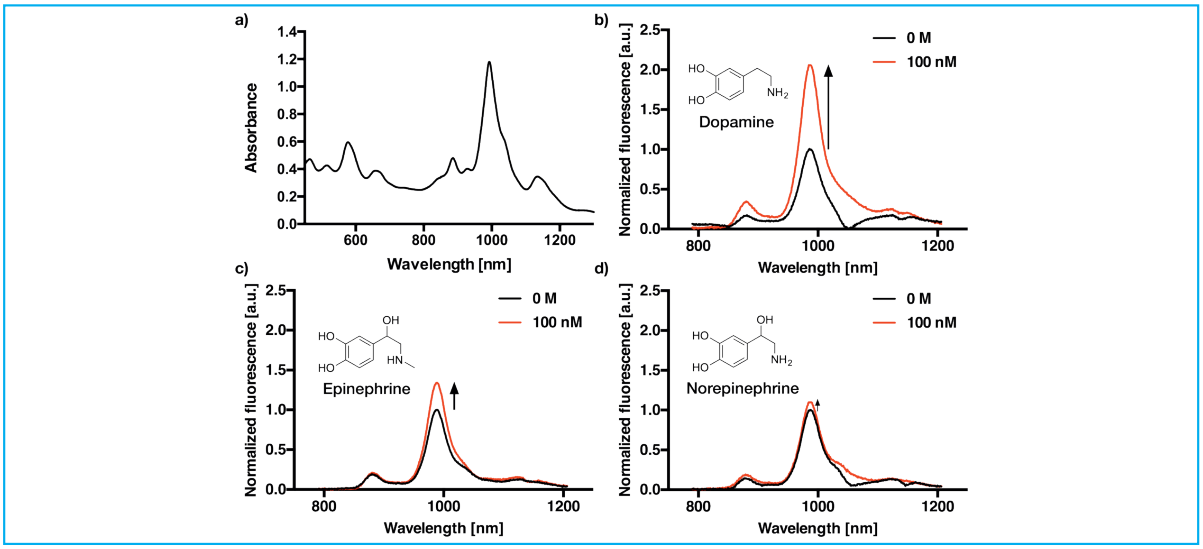


Figure 2, Absorbance and fluorescence spectra of DNA-wrapped SWCNTs. (a) vis-nIR absorbance spectrum of DNA-wrapped SWCNTs. (b,c,d) nIR-fluorescence spectra of $(GT)_{10}$ functionalized SWCNTs excited at 560nm before and after the addition of 100 nM dopamine (b), epinephrine (c) and norepinephrine (d).[7]

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