NS1 NanoSpectralyzer® Application Note 2

Assessing SWCNT Dispersion Quality

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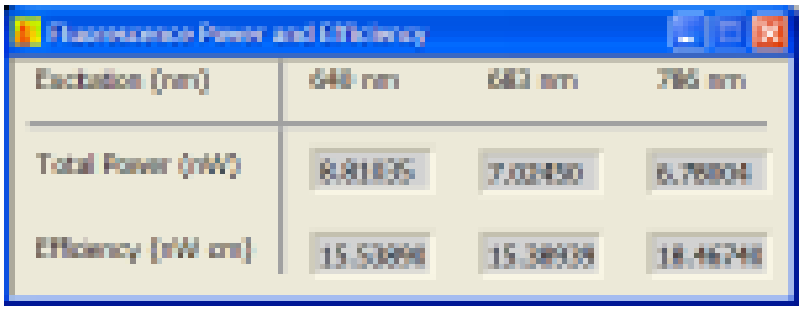
Total near-IR Emission

Dispersed semiconducting SWCNTs can emit near-IR fluorescence if they are free of growth defects, have not undergone sidewall chemical reactions, and are individually suspended rather than aggregated into bundles with other nanotubes. The measured fluorescence intensity from an SWCNT dispersion therefore depends not only on optical excitation power and nanotube concentration, but also on the sample's "quality."

To allow simple quantitative assessment of this quality, the NS1 NanoSpectralyzer automatically measures and reports the total (spectrally integrated) near-IR emission power from the sample for each excitation wavelength, as shown in the first row of the box below:



These values for total emission power allow one to compare a set of related samples (prepared with the same surfactant and equivalent sources of SWCNTs) to find the relative concentrations of disaggregated pristine nanotubes that they contain.

Sample Quality Index (Emission Efficiency)

The second row in the box shows the spectrally integrated emission values after they have been adjusted to account for the sample's fractional absorption of excitation light. These Efficiency values can be viewed as uncalibrated quantum yields that provide a figure of merit for near-IR "brightness." Efficiency values are highest for the purest and most completely dispersed samples because excitation light is absorbed not only by the emissive species (pristine disaggregated SWCNTs), but also by nonemissive components (imperfect nanotubes, bundled nanotubes, and impurities). The Efficiency values therefore provide a sensitive quality index. Measured values of this index can be 10,000 times higher for an excellent SWCNT dispersion than for a poor one.

Dispersion Stability

The most sensitive symptom of aggregation in an SWCNT dispersion is loss of fluorescence emission.

This occurs with the formation of small SWCNT bundles, and is detectable by fluorimetry far in advance of visible flocculation. To check the stability of a SWCNT dispersion, simply place the sample in a sealed cell into the NS1

and use the Sequence Acquisition mode to measure its fluorescence spectrum with one excitation wavelength at appropriate time intervals (e.g. once per hour during an overnight run). Stable dispersions will show no changes in emission signals during such runs, whereas unstable dispersions will decrease in emission.

Technical notes:

- Total Power and Efficiency values depend on excitation wavelength and on the (*n*,*m*) composition of the sample. Quantitative comparisons are valid only among samples with the same (*n*,*m*) composition, excited at the same wavelength.
- Efficiency values are obtained by dividing Total Power by sample absorbance in a 1 cm path length at the excitation wavelength. Efficiency values are computed automatically only in NS1 units equipped with the Visible Absorbance option.
- The NS1 performs fluorescence measurements using a very short effective path length, minimizing distortions from the inner filter effect. To obtain reliable Efficiency values, the sample's absorbance at the excitation wavelength should not exceed 1 per cm.