Zymosense Inc - Ames, IA
Zymosense.com
info@zymosense.com

Opportunities of Single-walled Carbon Nanotube Probes

Semiconducting single-walled carbon nanotubes (SWCNTs) feature a unique combination of properties which make them suitable for diagnostics. These properties include: (1) transmission in the biologically transparent near-infrared (NIR) optical window, (2) high photostability, (3) stable transmission (i.e., no 'blinking'), (4) a facile means of dispersion into aqueous media, and (5) a uniquely high sensitivity to their local environment. This simplifies development of SWCNT fluorescent sensors; a material or recognition element may be easily grafted onto the SWCNT surface to produce a ready-to-use fluorescent sensor.

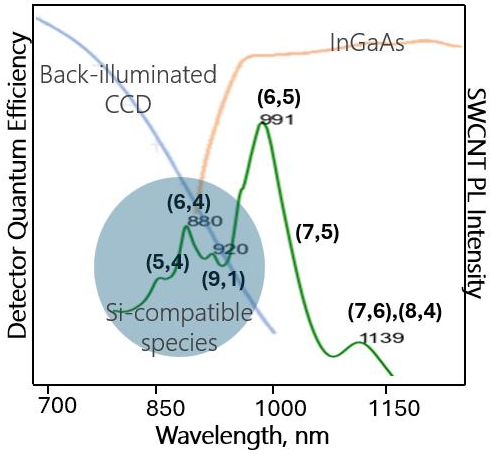

Figure 1. Overlaid spectra of detector efficiencies and SWCNT emission. Shaded region contains species which emit within the range of sensitivity of silicon photodetectors.

The NIR Detection Bottleneck

While these advantages would otherwise make SWCNTs commonplace, SWCNTs are held back by two limitations: (1) polydispersity of as-produced stocks and (2) emission outside the wavelength range of common silicon photodetectors, shown in Figure 1. Addressing this latter disadvantage is critical to enabling more widespread use of SWCNT sensors. While silicon photodetectors have been produced at such a scale to enable high-performance on common consumer products (e.g., mobile phones), NIR-sensitive semiconductors, namely InGaAs, lack the necessary ubiquity. As a result, NIR imaging tools often cost orders of magnitude more than visible spectrum tools and offer poorer resolution. This is often with the added requirement of active cooling to reduce the intrinsically higher noise of InGaAs.

Small Diameter Nanotubes

Zymosense has developed a method to address both limitations. By purifying and enriching otherwise-scarce small-diameter SWCNTs, we can make SWCNT solutions that can be detected via silicon cameras, as shown in Figure 2.

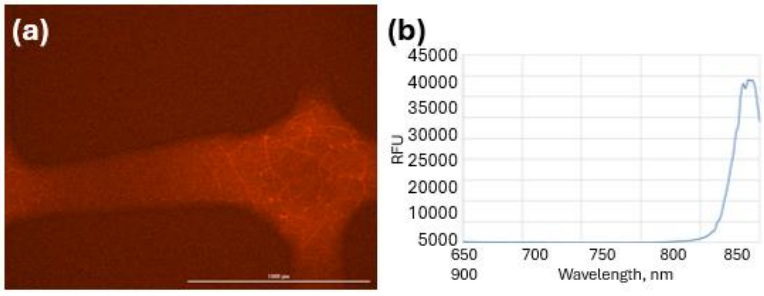

Figure 2. Demonstrated signal from enriched (6,4)-SWCNT with (a) Agilent Cytation 5 and (b) Tecan Spark.

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We are able to produce small-diameter SWCNTs at two different purity and size scales. A (6,4)-enriched mix (Figure 3a) can be produced at the tens of milligrams scale, and a (6,4)-pure fraction (Figure 3b) can be produced at the milligram scale. This allows us to serve both high-end and large-scale applications.

These enriched and purified SWCNTs can be produced in a variety of form-factors: surfactant dispersions, dry powders, and customer-requested aqueous dispersion. As we expand our catalog, these SWCNTs will also be useable for spectral multiplexing applications.

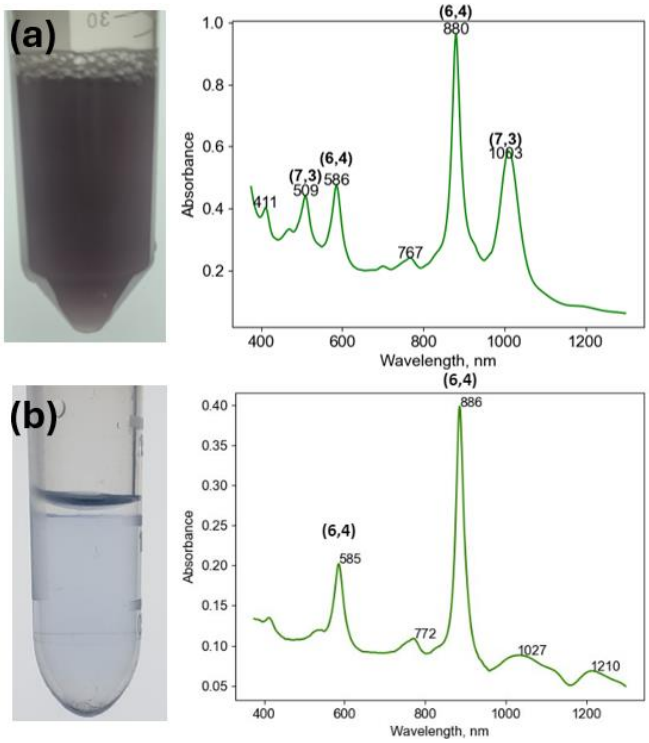

Figure 3. Photos and absorbance spectra of (a) bulk enriched (6,4)-SWCNT and (b) purified (6,4)-SWCNT.