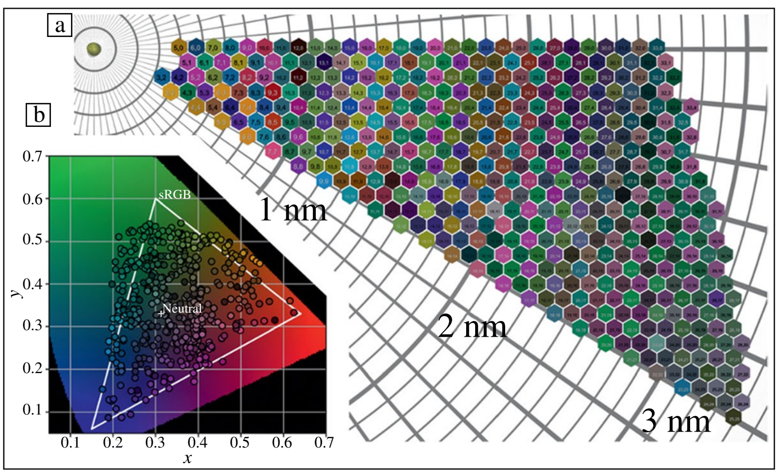
Single-walled carbon nanotubes bring color to carbon science

Carbon materials are usually colorless or black. For example, while diamond is transparent, graphite, graphene, and carbon nanotubes are black. Although these materials are recognized as super black, some studies have shown that single-walled carbon nanotubes (SWCNTs) can exhibit color. Now, an international research group has generated a theoretical model to predict some of the colors in SWCNTs varying in chirality and diameter (*n*, *m*). The researchers predicted the colors of 466 different (*n*, *m*) SWCNTs that can then be used to develop pure carbon dyes, electrochromic devices, and other optical applications.

Esko I. Kauppinen and colleagues at Aalto University School of Science, together with co-workers at Dalian Maritime University, Peking University, and Rice University, reported that the colors of these carbon nanotubes would depend on their absorption of light. The wavelengths that are not absorbed by the SWCNT will reflect a color in the visible spectrum such that they do not appear black. The researchers published their work in a recent issue of *Advanced Materials* (https://doi.org/10.1002/adma.202006395).



(a) Map of the most vivid colors of 466 (*n*, *m*) carbon nanotube species; (b) chromaticity diagram. Credit: *Advanced Materials*.

Figure a reveals the color map of the different 466 (*n*, *m*) SWCNTs. SWCNTs with smaller diameters showed more vivid colors than those with larger diameters. This variety of colors can also be observed in **Figure b**, in which a chromaticity diagram is shown in the range of colors red, green, and blue. These figures demonstrate the different SWCNTs that could be predicted by varying combinations of chirality and diameter.

The researchers verified these predicted colors with preexisting experimental data. They found only a small inconsistency between the experimental and theoretical results. The chromaticity and luminosity of the sample varied, but the tones matched. The research group explained that this might be due to the sample's concentration, light, and photography, for example. The research team established a coloration model to understand the mechanisms of the colors of the SWCNTs.

This finding is significant for the materials community since SWCNTs are conductive materials and have excellent electrical, optical, mechanical, and chemical properties (see *Nano Letters*, https://doi.org/10.1021/nl080302f). These nanotube films are also ductile and could be useful for the generation of solar cells, according to Kauppinen's statement in a news release.

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