Narrow-band single-photon emission through selective aryl functionalization of zigzag carbon nanotubes

September 27, 2018

An effort by researchers in the Center for Integrated Nanotechnology has been advancing the development of chemically controlled defects in carbon nanotubes as room-temperature single photon emitters, which are of significant interest for enabling new optical approaches to quantum information processing.

The defect behavior they study is introduced by covalent chemical functionalization of the nanotube. The team's previous work has shown that this chemistry can lead to multiple binding configurations of dopant molecules (the defects). These multiple configurations in turn lead to a broad range of possible defect-state photoluminescence emission wavelengths.

Ultimately, applications require a significantly narrower wavelength range in the emission response, in order to provide a high degree of uniformity. The work in the Sept. 3 *Nature Chemistry* paper, Narrow-Band Single-Photon Emission through Selective Aryl Funnctionalization of Zigzag Carbon Nanotubes, aims to address how to control and narrow the emission wavelength range through control of the functionalization chemistry.

The researchers showed in this work that they can narrow the response by a factor of 4-6 by functionalizing so-called zigzag nanotube structures. The narrowed response results from the unique symmetry of the zigzag nanotube physical structure. Quantum chemical theory modeling of the response allowed them to understand the origin of the spectral narrowing, coauthor Stephen Doorn said. "The theory results also led us to the realization that only a particular type of chemical binding (to so-called 'ortho' binding sites) results from our chemistry. This latter discovery is an especially significant advance in our understanding of the reaction mechanisms in carbon nanotube chemistry."

The paper's authors are Avishek Saha, Brendan J. Gifford, Xiaowei He, Geyou Ao, Ming Zheng, Hiromichi Kataura, Han Htoon, Svetlana Kilina, Sergei Tretiak and Stephen K. Doorn.