Many colours from a single dot

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Physicists Bart van Dam and Katerina Newell (Dohnalova) from the UvA Institute of Physics, in collaboration with Emanuele Marino and Peter Schall as well as colleagues from the University of Twente and Jiljin University in China, have shown that a single nanoparticle can be used to emit different colours of light. Their results, which were published in the nano- and microphysics journal *Small*, show that the particles under consideration may be a very efficient and versatile tool to produce light of all colours at tiny scales.

Carbon dots are carbon-based fluorescent nanoparticles that can be prepared to show photoluminescence with tunable colour from blue to red, which makes them an interesting material for lighting applications and bio-imaging. The mechanism underlying this tunable emission appears to be very much dependent on the internal structure of the carbon dots, which differs amongst various preparation techniques. Hence, a general mechanism for all carbon dots cannot be formulated. In most cases, the emission origin is ascribed to the different emission colours of the individual carbon dots within the sample, arising from their different size and/or chemical composition.

To investigate the origin of the tunable emission in the material that the researchers from UvA-IoP obtained in collaboration with University of Twente and Jilin University, they studied the emission of individual carbon dots and compared it to the emission of the whole sample. Using a technique called single-dot spectroscopy, they demonstrated that the emission colour of the individual carbon dots can be tuned from blue to red by changing the excitation wavelength, suggesting that multiple

colour sites are present and active within a single nanoparticle.

The tunable single-dot emission results from the presence of different emissive channels within a single dot—the blue emission related to small graphene-like flakes within the carbon core and the green and red emission related to oxygen and nitrogen functional groups on the surface of the carbon dot.

Since such carbon dots can be prepared via a facile single-step chemical synthesis, these findings demonstrate that it is viable to engineer different emission colours within a single nanoparticle. This makes carbon dots even more versatile than organic dyes or inorganic quantum dots, where the emission of a single molecule or quantum dot is fixed, opening up new routes towards engineering of light-emission on the nanoscale.

More information: Bart van Dam et al. Excitation-Dependent Photoluminescence from Single-Carbon Dots, *Small* (2017). DOI: 10.1002/smll.201702098

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