Nanoscale carbon allotrope at zero-dimension: From small carbon nanoparticles to carbon dots and their organic hybrids

Ya-Ping Sun
Department of Chemistry, Clemson University, Clemson, South Carolina 29634, USA
Email: syaping@clemson.edu

In the vast research field on carbon nanostructures, a seemingly broadly accepted family configuration of nanoscale carbon allotropes is such that fullerenes take the zero-dimensional dot spot, in perfect harmony with one-dimensional carbon nanotubes and two-dimensional graphene nanosheets. More recently, however, a threat to the nice "family value" has been the emergence of small carbon nanoparticles, which are carbon particles of a few nanometers in size without any defined crystal structures or largely amorphous and populated with abundant surface and other defects. The growing experimental evidence has revealed the unique and/or advantageous optical and photoexcited state properties and photoinduced redox characteristics of the small carbon nanoparticles, especially the spectacular performance enhancements upon their being effectively surface passivated by organic species for the hard-core/soft-shell nanostructures defined as carbon dots [1-4]. Thus, the ugly and dirty dot-like carbon particles have been elevated to the position of being able to compete with pretty and perfect fullerenes, which by the way are nano-sized molecules strictly speaking, for the title of nanoscale carbon allotrope at the zero-dimension. Nevertheless, carbon dots are not short of controversies, which are due largely to the fact that samples sold or labeled as "carbon dots" in store or literature reports, respectively, are often not what they are advertized, but complex mixtures of varying structures and compositions. Some of these will be discussed in the presentation, so are challenges and opportunities in this seemingly rapid expanding research field.

References

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