Light Science & Applications

Phosphorescence From Diamond

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Besides high hardness, diamond possesses several unique properties including high thermal conductivity, high carrier mobility, high breakdown field, various color centers, and good chemical stability, which make it a promising candidate in semiconductor devices and single-photon sources. Due to the existence of luminescent defects, such as nitrogen-vacancy, silicon-vacancy, and germanium-vacancy centers, etc, diamonds with rigid cubic lattice structure have been exploited as an ideal platform for quantum optics. Phosphorescence refers to the process in which material emits light after being exposed to external sources of energy. It has long been reported that phosphorescence can be observed from diamond. But the mechanism is still not clear. In this work, diamond with ultralong phosphorescence lifetime has been investigated. The diamonds show two phosphorescence emission bands centered at 470 nm and 580 nm, which have a lifetime of 31 s and 93 s, respectively, outperforming other reported diamond materials. Temperature-dependent photoluminescence spectra and lifetime decay curve verify that there may be a three-level system with donors, electron traps and acceptors in the diamonds, where the electron trap levels can capture excited carriers and then release to recombination under thermal activation. Density functional theory calculations further confirm the long-lifetime phosphorescence emission is originated from the three-level system caused by B-Fe and B-Na co-doping. In terms of the thermally-activated phosphorescence property, the phosphorescence of the diamond has been demonstrated in data storage with high repeatability (20 cycles without any luminescence attenuation) and long durability (more than 3600 s).

Short Bio:

Chongxin Shan received his bachelor degree from Wuhan University, and PhD degree from Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Science. Currently he is a professor of Zhengzhou University, China. His research interest is mainly focused on diamond based materials and devices.