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A bubble-induced ultrastable and robust single-photon emitter in hexagonal boron nitride

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Quantum emitters in van der Waals (vdW) materials have attracted lots of attentions in recent years, and shown great potentials to be fabricated as quantum photonic nanodevices. Especially, the single photon emitter (SPE) in hexagonal boron nitride (hBN) emerges with the outstanding room-temperature quantum performances, whereas the ubiquitous blinking and bleaching restrict its practical applications and investigations critically. The bubble in vdW materials exhibits the stable structure and can modify the local bandgap by strains on nanoscale, which is supposed to have the ability to fix this photostability problem. Here we report a bubble-induced high-purity SPE in hBN under ambient conditions showing stable quantum-emitting performances, and no evidence of blinking and bleaching for at least one year. Remarkably, we observe the nontrivial successive activating and quenching dynamical process of the fluorescent defects at the SPE region under low pressures for the first time, and the robust recoverability of the SPE after turning back to the atmospheric pressure. The pressure-tuned performance indicates the SPE origins from the lattice defect isolated and activated by the local strain induced from the bubble, and sheds lights on the future high-performance quantum sources based on hBN.

SHORT BIO:

Jian-Shun Tang is currently a professor of University of Science and Technology of China. His primary research field is the quantum light source and its applications in the study of quantum-information technologies and the fundamental problems of quantum physics. Over ten papers have been published in the SCI journals of Nature Photonics (2), Nature Communications (1), Phys. Rev. Lett. (3), Optica (1) etc., as the first or corresponding author. The H factor is 10. He derived the Rao Yutai First Prize in Fundamental Optics in 2016, entered the Youth Innovation Promotion Association of Chinese Academy of Sciences in 2017, and supported by the NSFC Excellent Young Scientists Fund in 2018. The primary research results are described as following. The first observation of the superposition state of the wave and particle properties of light is realized. This experiment “redefines the concept of wave-particle duality”, and “defies the conventional boundaries set by the complementarity principle”. The nonlocal quantum simulator is realized, and it is used to investigate the no-signalling problem in the parity-time symmetric theory. The temporal multimode quantum memory of the deterministic single photons emitted from the quantum dot is realized, and the number of the memorized modes is the most to date. The power-recycled weak-value-based metrology is realized, whose precision surpasses the precision limit of the classical protocol. Two direct measurement methods of quantum coherence have been developed in the framework of resource theory, which provide more tools for the studies of quantum resource. His researches were reported by scientific medias like Nature Photonics, Nature Physics, New Scientist, Nature China and Phys.org, etc., and several works were cited in the review papers of Review of Modern Physics.