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Electrical excitation of color centers in diamond: the route to efficient single-photon sources

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Abstract

The ability to operate at the single-photon level opens new prospects for a wide range of novel applications ranging from unconditionally secure optical communication lines to quantum computers. Practical implementation of quantum information technologies requires nonclassical light sources which can deliver single photons on demand. At present, color centers in diamond and related wide-bandgap semiconductors are considered as the most promising platform for true single-photon sources thanks to their remarkable optical characteristics under ambient conditions. However, from the practical point of view, single-photon sources should be driven electrically, which is challenging in the case of diamond, since diamond is more an insulator than a semiconductor.

Here, we discuss how to overcome the existing limitation and design efficient electrically driven single-photon sources based on diamond. We reveal the mechanism of color center electroluminescence and show that it is based on the electron and hole exchange between the color center and diamond crystal. Our theoretical and numerical results accurately reproduce recent experimental data. Moreover, we show how to increase the photon emission rate from electrically pumped color centers to 100 Mcounts per second, which provides a foundation for the development of practical quantum light devices based on diamond.

The speaker

Dmitry Fedyanin is a senior research fellow at the Moscow Institute of Physics and Technology (MIPT). He received the M.Sc. degree in 2012 from MIPT and obtained his Ph.D. in 2013. In 2011 he was awarded the Medal of the Russian Academy of Science and in 2012 he received the European Material Research Society Young Scientist Award. His current research is focused on nanoscale and quantum optoelectronics for data-processing, communication, and sensing applications.