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New color centers in diamonds: Prospects of application

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Color centers in diamond are known for a long time, they determine the shades of color of this mineral. Whereas earlier diamonds of different colors were of interest to people, first of all, from the point of view of the price of this precious stone, in the last few decades diamonds with color centers attract a huge interest in connection with their optical properties. At the present time, color centers are introduced into diamonds artificially with the help of various techniques. Color centers are capable to both absorb radiation selectively along the wavelengths and emit light in different spectral ranges. It turned out that some centers can give a very narrow emission line and it is possible to obtain radiation from single centers, which allows one to investigate their quantum nature. The technologies can produce a nanodiamond containing only one optical center, which is promising for the needs of quantum informatics (sources of single photons for quantum information processing, qubits in quantum computers). Passporting the spectral characteristics of individual particles, it is possible to create unique optical labels that protect against counterfeiting. In a number of centers, optically detected magnetic resonance (ODMR) was demonstrated, which showed very high sensitivity to external factors. This opens up incredible possibilities for the use of color centers in diamond as point sensors. In particular, point-like detectors of the temperature (accurate to mK), magnetic field (up to nT, with the ability to determine the direction and magnitude of the magnetic field from a single atom or molecule), electric fields, deformations have already been demonstrated. In addition, there are prospects for application in biology and medicine. Here I'll focus on the results obtained in the Institute of Spectroscopy in collaboration with our colleagues from other institutions. The known for a long time NV and SiV color centers and a new optical center in diamond associated with an admixture of germanium (GeV) were investigated. Our research has shown that GeV centers have unique characteristics, in many respects superior to those of the previously studied SiV and NV centers. In particular, a very bright glow is observed in the red-orange region of the spectrum (see the figure). I'll discuss interesting isotopic effects connected both with carbon and with germaniu and silicon; the luminescence decay times and the quantum yield; ab initio calculations of the electronic structure and of local mode frequencies; possibilities of practical application. The decisive contribution of my colleagues and coauthors, as well as a financial support by the Russian Science Foundation under Grant № 17-72-10293, are acknowledged.

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