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Production of color centers in nanodiamond

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Abstract

Diamond particles containing fluorescent color centers provide combination of outstanding photostability, sensitivity of fluorescence to external stimuli and excellent biocompatibility attractive for life science applications. Until recently, however, the fluorescent color palette of N-based centers was restricted to particles emitting only in red or green, based on NV centers produced in type Ib synthetic diamond, or NVN centers produced in type Ia natural diamond, correspondingly. Limited color options impacts applications of fluorescent nanodiamonds (FND) in multiplexed biological imaging. Here we report on a breakthrough method of production of multicolor diamond particulates using ultra-high temperature annealing (>1500 °C), which generates conditions for the formation of one-, two- and three-atom nitrogen complexes with vacancies in electron irradiated type Ib synthetic diamond, providing vibrant luminescence in the red (NV), green (NVN) and blue (N3 centers) spectral ranges, correspondingly. Remarkably, the ultra-high temperature treated particles containing NV centers demonstrated improved magneto-optical properties and open routes for multiplexed labeling combined with sensing when NV centers coexist with NVN or N3 centers within individual particles. Moreover, enhanced 13C optical hyperpolarizability of the treated particles was also observed, which advocates a new paradigm in dual-mode fluorescence/magnetic resonance imaging enabled by diamond contrast agents.