Nonlinear optical response from diamonds; the effect of NV centers

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ABSTRACT

The optical and magneto properties of the negatively charged nitrogen-vacancy (NV) center in diamond has been extensively investigated because of its application to quantum sensing, such as magnetic and electric fields and to quantum information technologies. In most cases, near-infrared luminescence upon the excitation by green laser can be controlled by the irradiation by microwave, which tunes the optical transition path between the excited and ground states. To extend the optical property of diamond over the current generation of linear optical regime, one requires ultrashort laser pulses, which enables one to induce nonlinear optical effect, such as the nonlinear refraction and nonlinear absorption. Almeida *et al*. recently reported on nonlinear optical spectra in high-purity diamond using femtosecond laser pulses with photon energy from 0.83 to 4.77 eV and measured coefficients for the nonlinear refraction and nonlinear absorption [1]. Because of the absence of defect-related bands below the band-gap (E_g = 5.5 eV), the two nonlinear optical effects were enhanced for E = $E_g/2$. Although there are several investigations on nonlinear optical effects in diamond and nano-diamonds [2,3], the effects of the NV center on the nonlinear optical phenomena have not yet been examined. This issue is, however, important to further study new functionality of diamond photonics to advance nonlinear quantum sensing. Here we explore the NV center induced nonlinear optical effects in pure diamond, specifically optical Kerr effect and two-photon absorption in transparent region using 800 nm light, at which NV related bands will be sensitive. It is found that both the nonlinear optical effects enhanced by the introduction of NV centers.

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