Manipulation of single spin of NV center in diamond

Norikazu MIZUOCHI[1,2*]
[1]Graduate School of Engineering Science, Osaka University 1-3, Machikane-yama,
Toyonaka-city, Osaka, 560-8531, JAPAN
[2]JST-CREST

NV center in diamond has been extensively interested because the single spin of it can be manipulated and detected at room temperature (RT). Furthermore, coherence time (T_2) of the NV center is very long. T_2 is the time to retain coherence (superposition state) and directly relates to the sensitivity of magnetic sensor. Therefore, the unique and excellent properties are expected to be applied for quantum computing, quantum communication and high-sensitive magnetic sensor with nano-scale resolution. By using the NV center, we previously investigated the quantum entanglement generation [1], spin coherence properties [2], and quantum coupling with a flux-qubit [3], and electrically driven single photon source at RT [4].

Recently, we realized deterministic electrical charge-state control of single NV^- center [5] by using a p-i-n diode that facilitates the delivery of charge carriers to the defect for charge state switching. A homebuilt confocal microscope was used to observe the single NV centers. By developing this technique for the decoupling of nuclear spins from the NV electron spin, realization of quantum memory of nuclear spin with very long T_2 can be expected. In addition, we also realized nearly perfect alignment (more than 99 %) of the NV axis along the [111]-axis [6]. This result enables a fourfold improvement of optical detection efficiency for spin information in quantum device and a fourfold improvement in magnetic-field sensitivity. These achievements are considered to be a crucial step towards elaborated diamond-based quantum spintronics devices.

These researches are supported ImPACT Program of Council for Science, Technology and Innovation (Cabinet Office, Government of Japan), SCOPE program, and JST CREST program. The p-i-n diode was produced by AIST in Japan.

References

[1] P. Neumann, & NM, et al., Science, 320, 1326 (2008).
[2] N. Mizuochi, et al., Phys. Rev. B, 80, 041201(R) (2009).
[3] X. Zhu, & NM, et al., Nature, 478, 221 (2011).
[4] N. Mizuochi et al., Nature Photon. 6, 299 (2012).
[5] Y. Doi, & NM, et al., Phys. Rev. X. 4, 01107 (2014).
[6] T. Fukui, & NM, et al., Appl. Phys. Express 7, 055201 (2014).