Dynamic nuclear polarization and relaxation in Si:P at very low temperatures

J. Järvinen[a], S. Vasiliev[a], D. Zvezdov[a,b], J. Ahokas[a], S. Sheludyakov[a], O. Vainio[a], T. Mizusaki[c], Y. Fujii[c], S. Mitsudo[c], M. Gwak[d], and S. Lee[d]

[a]Department of Physics and Astronomy University of Turku, 20014 Turku, Finland
[b]Kazan Federal University, 420008 Kremlyovskaya str., Kazan, Russia
[c]Research Center for Development of Far-Infrared Region, University of Fukui, Fukui, Japan
[d]Division of Materials Science, Korea Basic Science institute

We report on studies of dynamic nuclear polarization (DNP) and nuclear and electronic relaxation times of ^{31}P donors in natural Si. After the pioneering work of Feher [1] the recent interest towards this system has been raised by the proposal of Kane [2] to utilize impurity atoms for quantum computing.
The samples were studied in strong magnetic field and temperatures below 1K. At these conditions donor electron spins are fully polarized and electron and nuclear relaxation times are very long. The DNP in such conditions is very efficient and pumping with very low RF powers (<1 μW) for reasonably short time ($\approx$1 hour) gives very high nuclear polarization of ^{31}P. DNP on the neighbouring ^{29}Si nuclei reduces strongly the ESR linewidth of ^{31}P. We discuss favourable conditions for DNP and possible physical mechanisms of the observed phenomena.

[1] G. Feher, Phys. Rev. **114**, 1219 (1959).
[2] B.E. Kane, Nature, **393**, 133 (1998).
[3] S. Vasilyev, J. Järvinen, E. Tjukanoff, A. Kharitonov, and S. Jaakkola, Rev. Sci. Instrum. **75**, 94 (2004).

Section: QS - Quantum solids

Keywords: nuclear spin, quantum solid, silicon