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N-V_{Si}–related center in non-irradiated 6H SiC nanostructure

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The nitrogen-vacancy (N-V) center in diamond and silicon carbide polytypic is well-known to be one of the best versions of a qubit that is able to demonstrate quantum computations at high temperature [1].

Here we present the first findings of the ordinary and electrically-detected ESR studies of the N-V_{Si}–related triplet center with spin state S = 1 in the planar p-type 6H-SiC nanostructure. This nanostructure was prepared by the non-equilibrium diffusion of boron under controlled injection of silicon vacancies (V_{Si}) at the temperature of T = 900^0C into the n-type 6H SiC (0001) wafer which was previously oxidized using the pyrolysis of silane. The quantum conductance, tunneling spectroscopy and SIMS measurements showed that the 6H-SiC nanostructure represents the ultra-narrow p-type quantum well, 2 nm, confined by the δ-barriers heavily doped with boron, 3 nm. The EDESR method by measuring the only magnetoresistance of the p-type quantum well under the high frequency generation from the δ-barriers appears to allow the identification of both the triplet center above noticed and the presence of the isolated silicon vacancies. Since the measurements of the positive magnetoresistance response under the high frequency generation were performed without any light illumination and injection of carriers from the contacts, the EDESR effects appear to result from the spin-dependent scattering of spin-polarized holes from the single paramagnetic centers at the edge channels of the p-type quantum well [2]. Therefore the resonant positive magnetoresistance data appear to be interpreted in terms of the interference transition in the diffusive transport of free holes between the weak antilocalization regime ($\tau_S > \tau_\varphi > \tau_m$) in the region far from the ESR of a paramagnetic point defect located inside edge channels and the weak localization regime ($\tau_\varphi > \tau_S > \tau_m$) in the nearest region of the ESR of that defect.

The ESR and EDESR data on the hyperfine (hf) structure related to the hf interaction with one ^{14}N nuclei seem to evidence that the triplet center is tentatively assigned to the N-V_{Si} defect. The striking result obtained in this work is that as distinct from the well-known N-V defects observed in the e-irradiated diamond as well as in the heavy n-irradiated and high temperature annealed n-type 6H SiC, the N-V_{Si} center has been found in the non-irradiated 6H-SiC nanostructure, with the larger value of the zero-field splitting constant D and anisotropic g-factor.

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