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Room-temperature photoelectrical detection of spins in silicon carbide

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Abstract

Optically addressable spins of point defects in semiconductors are a promising platform for quantum technologies such as quantum information technologies and quantum sensing. Silicon carbide hosts various spins with long coherence times even at ambient conditions. In addition to the electronic spin, the surrounding nuclear spins in the host material can couple to the electronic spin and play an important role as a quantum memory to store the quantum information and enhance the sensitivity of quantum sensors. Usually, these spins are read out optically by counting emitted photons. However, the photoelectrical detection of magnetic resonance (PDMR) technique allows the electrical spin readout by fabricating the spin detection electrodes on the semiconductor and reading out the spin-dependent photocurrent. The electrical detection method is particularly promising in SiC, a semiconductor with excellent electrical properties. High electronic device compatibility of SiC will enable on-chip integration of the quantum system with peripheral functionalities and the miniaturization of the SiC-based quantum devices. Also, electrical readout is expected to achieve superior spin detection sensitivity thanks to the easier control of the photoionized charge collection by the electric field compared to the optical detection, which suffers from limited photon collection due to the total internal reflectance in the high refractive index material. In this talk, we present our recent studies on high-resolution electrical detection of electronic spins of silicon vacancies and surrounding nuclear spins in SiC by the PDMR technique.