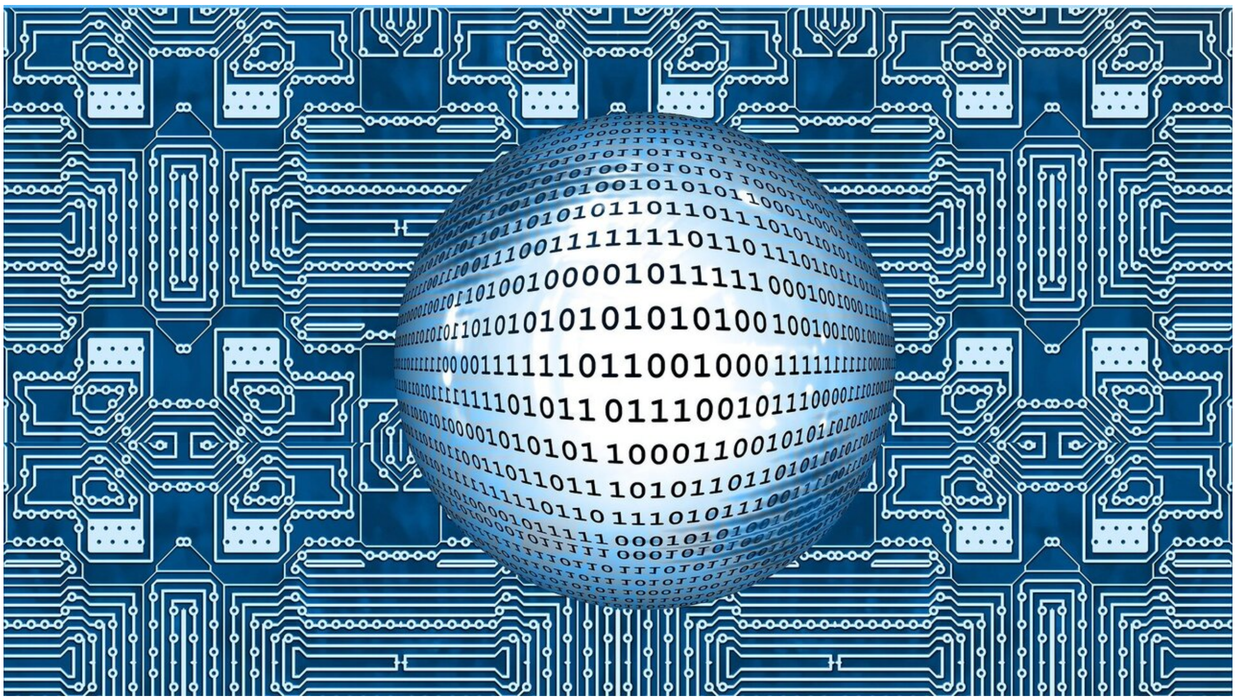
The era of single-spin color centers in silicon carbide is approaching

July 19 2021



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Prof. Li Chuanfeng, Prof. Xu Jinshi and their colleagues from Prof. Guo Guangcan's group at the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences (CAS), realized the high-contrast readout and coherent manipulation of a single silicon carbide divacancy color center electron spin at room temperature for the first time. They were working in cooperation with Prof. Adam Gali, from the

Wigner Research Centre for Physics in Hungary. This work was published in *National Science Review* on July 5, 2021.

Solid-state spin color centers are of utmost importance in many applications of quantum technologies, primarily the nitrogen-vacancy (NV) center in diamond. Since the detection of individual NV defect centers in diamond with room-temperature was reported in 1997, the NV centers in diamond have been applied to versatile fields, including quantum computing, quantum networking and quantum sensing.

Recently, to take advantage of more mature material processing and device integration technologies, researchers seek similar color centers in other semiconductor materials. Among them, the spin color centers in silicon carbide, including silicon vacancies (missing a silicon atom) and divacancies (missing a silicon atom and an adjacent carbon atom), have attracted broad interest due to excellent optical and spin properties.

However, the typical readout contrast via room-temperature coherent manipulation of the single silicon vacancy color centers is only 2%, and the photon count rate is also as low as 10 kilo counts per second. These shortages restrict the practical application of the coherent manipulation of the single silicon vacancy color centers at room temperature.

Researchers from USTC implanted defect color centers in SiC with their ion implantation technique to manufacture a divacancy color center array. They achieved spin-coherent manipulation of the single divacancy color center at room temperature with the optically detected magnetic resonance (ODMR), at the same time, they found that one type of divacancy color centers (called PL6) had a 30% spin readout contrast, whose single-photon emission rate was up to 150 kilo counts per second.

These two important parameters are an order of magnitude higher than the silicon vacancy color center in SiC. For the first time, the spin color centers of SiC showed excellent properties comparable to the diamond NV color center at room temperature. Especially, the coherence time of the electron spin at room temperature was extended to 23 microseconds. Moreover, the research team also realized the coupling and detection of a single electron spin and a nearby nuclear spin in SiC color centers.

This work lays the foundation for building room-temperature solid-state quantum storage and scalable solid-state quantum networks which are based on the SiC spin color center system. It is essential for the next generation of hybrid quantum devices to integrate spin defects with a high readout contrast and a high photon count rate into high-performance SiC electron devices.

More information: Qiang Li et al, Room temperature coherent manipulation of single-spin qubits in silicon carbide with a high readout contrast, *National Science Review* (2021). DOI: 10.1093/nsr/nwab122

Provided by University of Science and Technology of China