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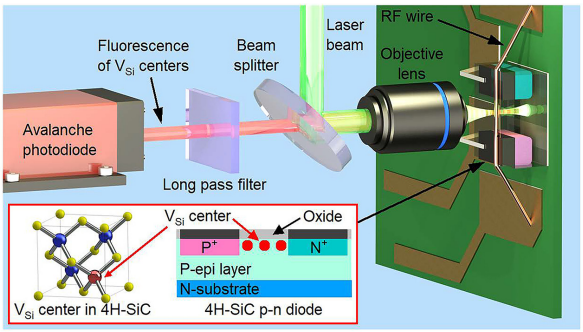
Silicon vacancy centers can be used as quantum sensors in hexagonal SiC to measure local temperature in an operating device.



Silicon carbide (SiC) holds promise as a semiconductor material for improving high-power and high-temperature electronics, such as reducing battery degradation for electric vehicles and solar power grids. To better understand and enhance the performance and reliability of SiC-based electronics, Hoang et al. developed a method to closely monitor the temperature in an operating hexagonal SiC device.

The developed method takes advantage of the negatively charged silicon vacancy centers, which emit optical signals that carry information about the local temperature. By monitoring the optical signals, the authors were able to use the vacancy centers as a quantum thermoelectric sensor to monitor the temperature changes of the device.

Putting their concept to the test, the authors created microdots of silicon vacancies in the hexagonal SiC device with proton beam writing, and monitored the optical signals of the silicon vacancy centers in the excited state via magnetic resonance, which allowed them to determine local temperatures in the device.

“This research is important for sustainable development goals for climate action, especially for affordable and clean energy. Power devices and batteries are key components for a low carbon society. Our proposed quantum sensor contributes to these,” said author Mutsuko Hatano.

Precise real-time temperature monitoring could help increase the safety and failure prediction of SiC-based devices. Next, the authors hope to extend this method to monitor the temperature and current simultaneously, as well as to measure the electric field inside of a SiC-based device.

Source: “Thermometric quantum sensor using excited state of silicon vacancy centers in 4H-SiC devices,” by Tuan Minh Hoang, Hitoshi Ishiwata, Yuta Masuyama, Yuichi Yamazaki, Kazutoshi Kojima, Sang-Yun Lee, Takeshi Ohshima, Takayuki Iwasaki, Digh Hisamoto, and Mutsuko Hatano, *Applied Physics Letters* (2020). The article can be accessed at https://doi.org/10.1063/5.0027603.

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