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Quantum Progress: Radiation-Free Creation and Patterning of Color Centers

Researchers at Stanford have developed a non-destructive method for generating and patterning optical color centers with nanoscale resolution *without* the need for high energy radiation. Color centers, which are optically active defects within the lattice structure of a host material, are exciting candidate **qubits** for quantum technology as well as **sensing** applications down to the single-molecule level. However, **two key challenges hindering the mass adoption** of optical color centers are poor material quality and lack of methods to control qubit spatial distributions. Existing fabrication methods rely on **destructive, high energy irradiation.** Hence, color center generation and patterning remains a **key bottleneck** to progress in the field.

The new method is based on depositing, treating, and annealing functional **'vacancy injection'** films on relevant materials (e.g., diamond, silicon carbide, silicon). This **non-destructive approach** enables a **higher level of control** and decreases host lattice damage. In sharp contrast to previous methods, the vacancies in host materials are **not generated by irradiation** but rather via lithographically patternable vacancy-injection film disposed on the host material. When exposed to elevated temperatures, the film absorbs substrate atoms, thereby realizing vacancies in the lattice of the host material.

Stage of Development
The researchers have demonstrated vacancy doping in diamond using the new approach. They have also shown the ability to pattern color centers on the nanoscale using conventional photolithography to pattern film deposition.

Applications

- Forming and patterning color centers
    - Quantum computing, quantum sensors (e.g., temperature, magnetic, electric field, optical near field, etc.), quantum imagers, super-resolution microscopy and more

Advantages

- Less destructive; method does not rely on high energy radiation
- Much greater spatial control

Patents

- Published Application: [WO2020096839]

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