Atomic defects in solid state hosts:  
A thousand opportunities


Summary

Atomic defects in solids - formed, for example, by impurities or vacancies - are presently emerging as an attractive platform for applications in areas ranging from quantum information processing, to photonics, to nanoscale sensing. Below we highlight recent work in our groups using the nitrogen-vacancy (NV) center in diamond, and a new single-photon emitter in hexagonal boron nitride (hBN), a novel 2D material.

Spin-assisted nanoscale imaging of thermal conductivity

Fig. 1: We use the electronic spin of an NV center attached to the tip of an AFM as a thermal sensor, to optically monitor the temperature at the AFM tip, in turn controlled via the application of a current. Ref: Laraoui et al., Nature Commun, 2015.

NV centers as a platform for long-term data storage in three dimensions

Fig. 3: We control the charge state of micron-scale ensembles of NV centers via the application of laser pulses of suitable wavelength, duration, and intensity, which can be visualized via a change in the NV fluorescence. The figure shows three alternative protocols for encoding the NV charge. Fig. 4: Using one of the protocols above (Fig. 3b) we write, erase, and re-write arbitrary data sets in three dimensions. Ref: Dhomkar et al., Science Advances 2016.

Characterization of single photon emitters in two-dimensional materials

Fig. 5: We investigate the room temperature optical properties of single fluorescing defects in hBN, the first of its kind in a two-dimensional material. Fig. 6: We find that upon laser excitation in the blue, the zero-phonon line in these emitters can exhibit gigantic jumps. Fig. 7: Some defects are observable under blue excitation but not under green light. Ref: Shotan et al., Nano Letters, 2016.