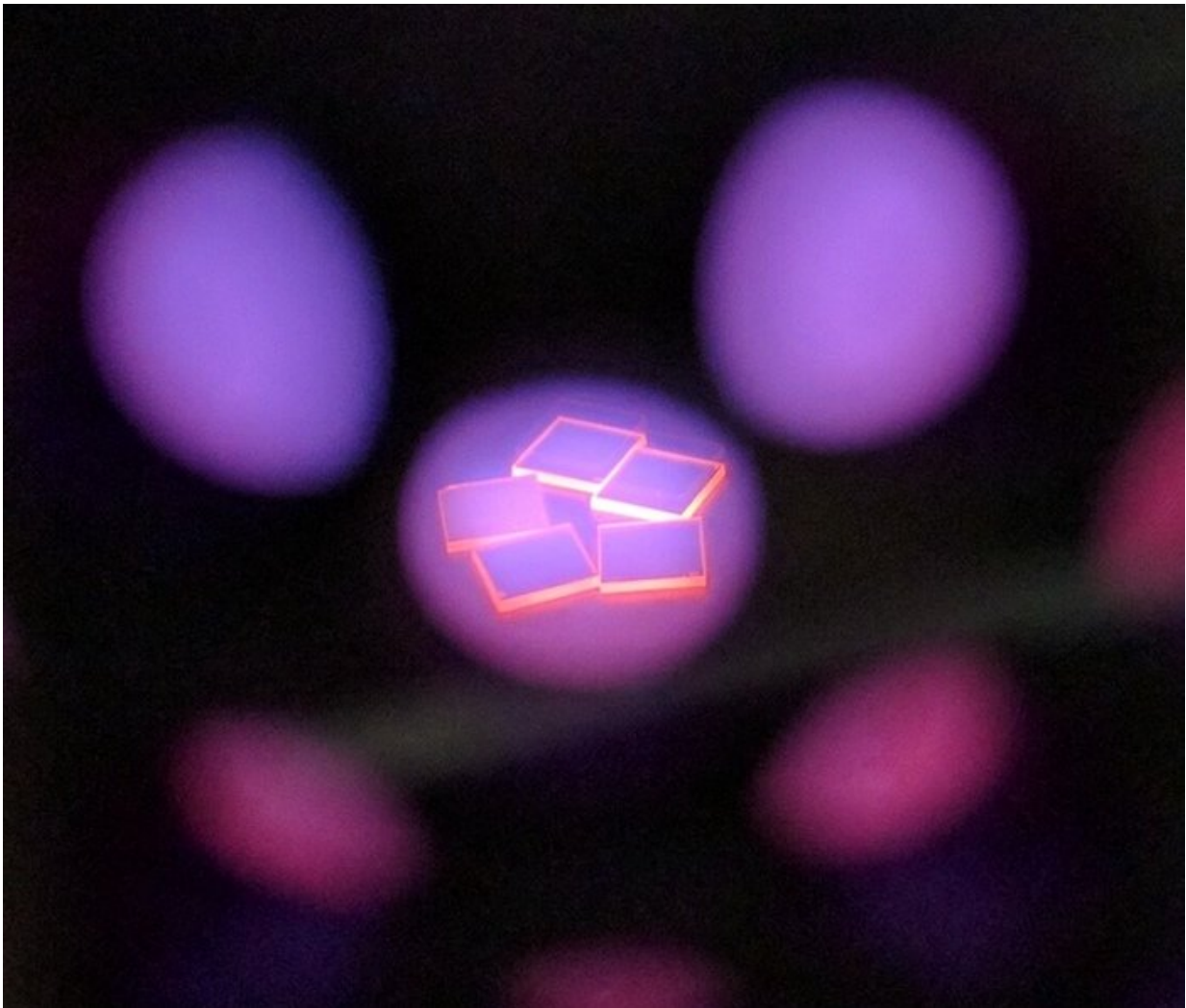


Diamonds show promise for spintronic devices

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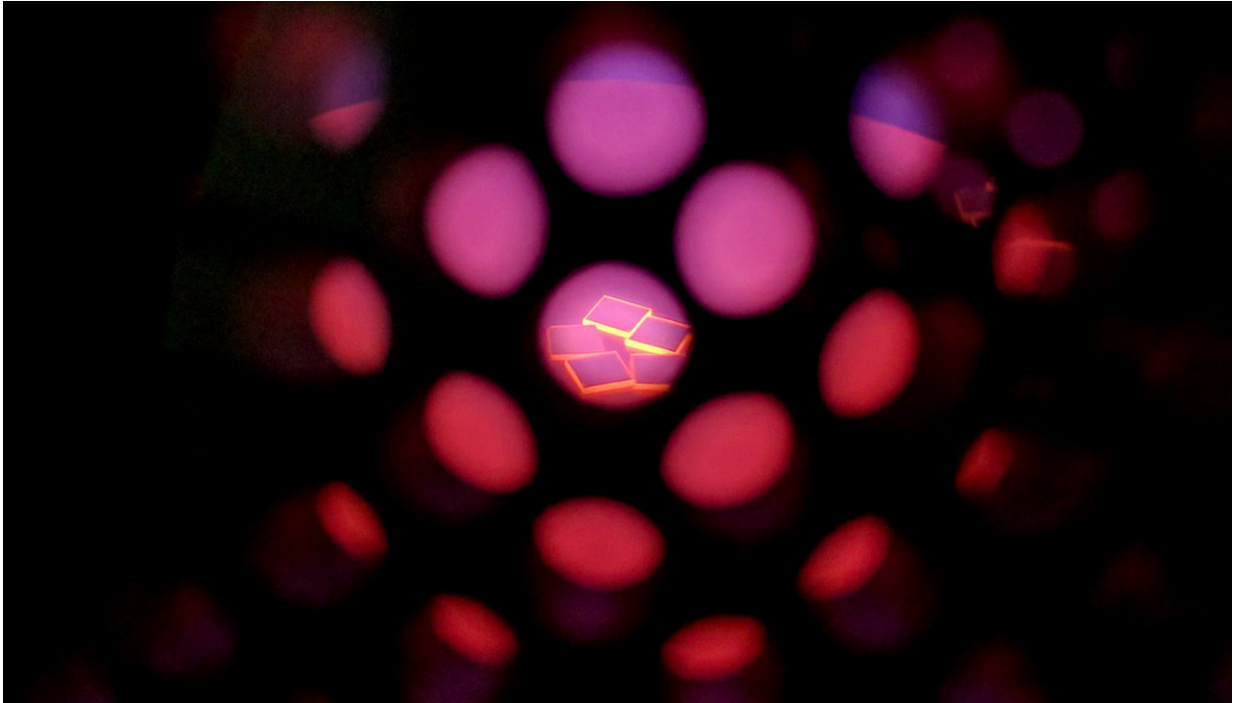
Diamond plates undergoing surface termination treatment in a hydrogen plasma.
Credit: Daniel Creedon

Conventional electronics rely on controlling electric charge. Recently, researchers have been exploring the potential for a new technology, called spintronics, that relies on detecting and controlling a particle's spin. This technology could lead to new types of more efficient and powerful devices.

In a paper published in *Applied Physics Letters*, researchers measured how strongly a charge carrier's spin interacts with a [magnetic field](#) in diamond. This crucial property shows diamond as a promising material for spintronic devices.

Diamond is attractive because it would be easier to process and fabricate into spintronic devices than typical semiconductor materials, said Golrokh Akhgar, a physicist at La Trobe University in Australia. Conventional quantum devices are based on multiple thin layers of semiconductors, which require an elaborate fabrication process in an ultrahigh vacuum.

"Diamond is normally an extremely good insulator," Akhgar said. But, when exposed to hydrogen plasma, the diamond incorporates hydrogen atoms into its [surface](#). When a hydrogenated diamond is introduced to moist air, it becomes electrically conductive because a thin layer of water forms on its surface, pulling electrons from the diamond. The missing electrons at the diamond surface behave like positively charged particles, called holes, making the surface conductive.



Diamond plates undergoing surface termination treatment in a hydrogen plasma.
Credit: Daniel Creedon

Researchers found that these holes have many of the right properties for spintronics. The most important property is a relativistic effect called [spin-orbit coupling](#), where the spin of a charge carrier interacts with its orbital motion. A strong coupling enables researchers to control the particle's spin with an [electric field](#).

In previous work, the researchers measured how strongly a hole's spin-orbit coupling could be engineered with an electric field. They also showed that an external electric field could tune the strength of the coupling.

In recent experiments, the researchers measured how strongly a hole's spin interacts with a magnetic field. For this measurement, the

researchers applied constant magnetic fields of different strengths parallel to the diamond surface at temperatures below 4 Kelvin. They also simultaneously applied a steadily varying perpendicular field. By monitoring how the electrical resistance of the diamond changed, they determined the g-factor. This quantity could help researchers control spin in future devices using a magnetic [field](#).

"The coupling strength of carrier spins to electric and magnetic fields lies at the heart of spintronics," Akhgar said. "We now have the two crucial parameters for the manipulation of spins in the conductive surface layer of diamond by either electric or magnetic fields."

Additionally, diamond is transparent, so it can be incorporated into optical devices that operate with visible or ultraviolet light. Nitrogen-vacancy [diamonds](#)—which contain nitrogen atoms paired with missing carbon atoms in its crystal structure—show promise as a quantum bit, or qubit, the basis for quantum information technology. Being able to manipulate spin and use it as a qubit could lead to yet more devices with untapped potential, Akhgar said.

More information: Golrokh Akhgar et al, G-factor and well width variations for the two-dimensional hole gas in surface conducting diamond, *Applied Physics Letters* (2018). [DOI: 10.1063/1.5010800](https://doi.org/10.1063/1.5010800)

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