



## Graphene & N-V centers

Graphene improves nanooptoelectronic readout devices.

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Nitrogen-vacancy centers in diamonds could be used to construct vital components for quantum computers. But so far it has been impossible to electronically read optically written information from such systems. Using a graphene layer, a team of scientists from the Nano-optoelectronics group led by Prof. at ICFO Frank Koppens and the research group led by Prof. Holleitner from Technische Universität München (TUM) has now just implemented such a read unit. The results from such study have been published recently in *Nature Nanotechnology*.

Ideal diamonds consist of pure carbon although natural diamonds always contain defects. The most researched defects are nitrogen-vacancy centers comprising a nitrogen atom and a vacancy. These might serve as highly sensitive sensors or as register components for quantum computers. However, until now it has not been possible to extract the optically stored information electronically.

The developed technique builds on a direct transfer of energy from nitrogen-vacancy centers in nanodiamonds to a neighboring graphene layer. When laser light shines on a nanodiamond, a light photon raises an electron from its ground state to an excited state in the nitrogen-vacancy center. The excited electron and the vacated ground state are seen as a dipole that, consecutively, induce a dipole of an electron and a vacancy in the neighboring graphene layer, which, in turn, induces an readout electric current.

The measurements need to be made extremely quickly because the generated electron-vacancy pairs disappear after only a few billionths of a second. With the experimental setup, the team was capable of measuring in the picosecond range (trillionths of a second), observing these processes very closely.

This study opens a new avenue for incorporating nitrogen vacancy centers as spin qubits into ultrafast electronic circuits, allowing sensors to measure extremely fast processes. Integrated into future quantum computers they would allow clock speeds ranging into the terahertz domain.