# An optical switch based on a single nano-diamond

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This shows the nanomanipulation of an artificial atom. Credit: ICFO

A recent study led by researchers of the ICFO (Institute of Photonic Sciences) demonstrates that a single nano-diamond can be operated as an ultrafast single-emitter optical switch operating at room temperature. The scientific results of this study have been published in *Nature*

*Physics*.

Electronic transistors have become a key component to modern electronics, drastically improving the speed of information processing of current technologies. An electronic transistor is a semiconductor device used to amplify and switch electronic signals. The much sought after optical transistor (the photonic counterpart of the electronic transistor) is poised to become a central ingredient in the development of optical signal processing. The motivation for using photons rather than electrons not only comes from their faster dynamics but also from their weaker interaction with the environment, which enable a high degree of integration and the realization of quantum operations.

Prior studies have demonstrated that single dye molecules can be operated as optical transistors with the disadvantage that they worked exclusively at extremely low temperatures. Such restrictions on the temperature made these optical transistors cumbersome for application to quantum computing.

However in this recent ICFO study, scientists have shown that a nano-size diamond at room temperature can act as an efficient optical switch controllable with light. A Nano-diamond containing a nitrogen impurity behaves like an artificial atom although much more stable at room temperature than a real atom due to its encapsulation. The ICFO scientists discovered a novel physical mechanism that enables the control of the way the nano-diamond interacts with light. While excited to its ON state by a green laser, a suitable near infrared illumination was found to act as an efficient and fast way to switch it OFF. Based on this simple concept, they were able to modulate the optical nano-diamond ON and OFF at extremely high speeds, demonstrating its robustness and viability for very fast information processing and quantum computer operations.

Quidant remarks that "what is really attractive about our discovery is that

our nano-switch combines very small dimensions (compatible with integrating a large number of them in a small area) with very fast response time (meaning lots of operations in a short time) and operation at room temperature".

This new technique will contribute to the development of future integrated optical circuits as well as quantum information processing for quantum computing.

**More information:** Michael Geiselmann, Renaud Marty, F. Javier García de Abajo & Romain Quidant, Fast optical modulation of the fluorescence from a single nitrogen–vacancy centre, *Nature Physics* (2013), DOI: 10.1038/nphys2770

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