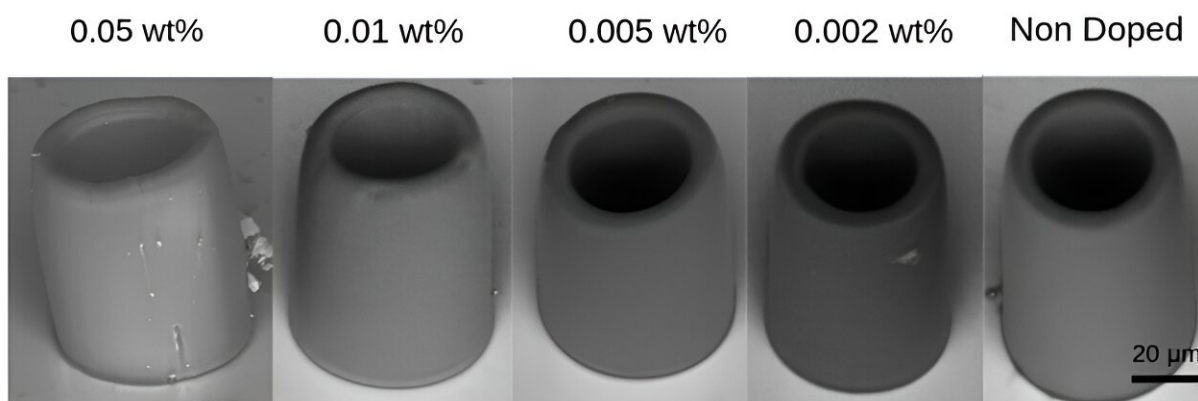


Embedding nanodiamonds in polymer can advance quantum computing and biological studies

December 13 2023, by José Tadeu Arantes



Cylindrical microstructures formed by a photoresist doped with different proportions of nanodiamond are shown in these scanning electron microscope images. Credit: IFSC-USP

A nitrogen-vacancy (NV) center is a defect in the crystal structure of diamond, where a nitrogen atom replaces a carbon atom in the diamond lattice and a neighboring site in the lattice is vacant. This and other fluorescent defects in diamond, known as color centers, have attracted researchers' attention owing to their quantum properties, such as single-photon emission at room temperature and with long coherence time. Their many applications include quantum information encoding and processing, and cell marking in biological studies.

Microfabrication in diamond is technically difficult, and nanodiamonds with color centers have been embedded in custom-designed structures as a way of integrating these quantum emitters into photonic devices. A study conducted at the University of São Paulo's São Carlos Institute of Physics (IFSC-USP) in Brazil has established a method for this, as described in an [article published](#) in the journal *Nanomaterials*.

"We demonstrated a method of embedding fluorescent nanodiamonds in [microstructures](#) designed for this purpose, using two-photon polymerization [2PP]," Cleber Mendonça, a professor at IFSC-USP and last author of the article, told Agência FAPESP. "We studied the ideal concentration of nanodiamond in the photoresist to achieve structures with at least one fluorescent NV center and good structural and optical quality." The photoresist is a light-sensitive material used in the fabrication process to transfer nanoscale patterns to the substrate.

Mendonça and his group have made extensive use of 2PP to fabricate three-dimensional microstructures. Simply put, 2PP is a direct laser writing technique in which a high-intensity laser beam is focused on a light-sensitive polymer resin that has not yet solidified to produce the microstructure of interest.

In the study, a nanodiamond solution in deionized water was added to the mixture of monomers that comprised the photoresist, and after all the requisite physicochemical procedures had been completed, microfabrication was performed by submitting the sample to pulses from a powerful titanium-sapphire laser controlled by dedicated software to define the exact coordinates of the beam.

"Fluorescence and Raman spectroscopy measurements were used to confirm the presence and location of the nanodiamonds, while absorbance measurements assessed scattering losses at higher concentrations. Our results show the feasibility of fabricating

microstructures embedded within fluorescent [nanodiamonds](#) via 2PP for photonics and quantum technology applications," the authors write in the article.

The study was part of the Ph.D. research of first author Filipe Assis Couto, with Mendonça as thesis advisor.

More information: Filipe A. Couto et al, Integrating Fluorescent Nanodiamonds into Polymeric Microstructures Fabricated by Two-Photon Polymerization, *Nanomaterials* (2023). [DOI: 10.3390/nano13182571](#)

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