TAU Researchers Develop Artificial Gold Nanoparticle to Improve Cancer Treatments

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Researchers at TAU have developed a nanotechnology that can serve as a basis for innovative medical approaches to diagnosing and delivering light-activated drug therapies for cancer patients.

The technology transforms a transparent calcite nanoparticle into a sparkling gold-like particle, turning an “invisible” particle into one that is visible despite its very small dimensions. According to the researchers, the new material can serve as a platform for innovative cancer treatments.

The approach introduces the concept of delivering bio-friendly optical resonances used in cancer imaging tests via a miniature nanoscale particle they produced. This development opens promising prospects for various biomedical applications, by enabling the use of a single designer-made nanoparticle for various clinical practices including sensing, photothermal therapy, photoacoustic tomography, bioimaging, and targeted drug delivery.

The development was conducted by an international team of scientists coordinated by Dr. Roman Noskov and Professor Pavel Ginzburg of TAU’s Iby and Aladar Fleischman Faculty of Engineering; Professor Dmitry Gorin of the Center for Photonics and Quantum Materials at the Skolkovo Institute of Science and Technology (Skoltech); and Dr. Evgeny Shirshin of the M.V. Lomonosov Moscow State University. The findings were recently published in the peer-reviewed journal Advanced Materials.

“This concept is the result of cross-disciplinary thinking at the interface between the physics of metamaterials [a material with properties that are not found in nature] and bioorganic chemistry, aiming to meet the needs of nanomedicine,” Dr. Noskov says. “We were able to create a mesoscopic submicron metamaterial from biocompatible components that demonstrates strong Mie resonances covering the near-infrared spectral window in which biological tissues are transparent."

The nanostructures capable of nanoscale light localization among its functions are particularly significant given existing challenges of biocompatibility due to traditional methods of engineering optical properties that often use toxic compounds and chemicals. The researchers have resolved this issue by employing gold nanoseeds and porous vaterite (calcium carbonate) spherulites, currently considered promising drug-delivery vehicles. This approach involves controllable infusion of gold nanoseeds into a vaterite scaffold resulting in a mesoscopic metamaterial – golden vaterite – whose resonance properties can be widely tuned by changing the quantity of gold inside the vaterite.

Additionally, high payload capacity of vaterite spherulites allows simultaneous loading of both drugs and fluorescent tags. To verify the performance of their system, the researchers demonstrated efficient laser heating of golden vaterite at red and near-infrared wavelengths, highly desirable in photothermal therapy and photoacoustic tomography.

"This novel platform enables the accommodation of multiple functionalities as simple add-ons that can be introduced almost on demand," Professor Ginzburg concludes. "Alongside optical imaging and thermotherapy, MRI visibility, functional biomedical materials, and many other modalities can be introduced within a miniature nanoscale particle. I believe that our collaborative efforts will lead to in vivo demonstrations, which will pave the way for a new biomedical technology."

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