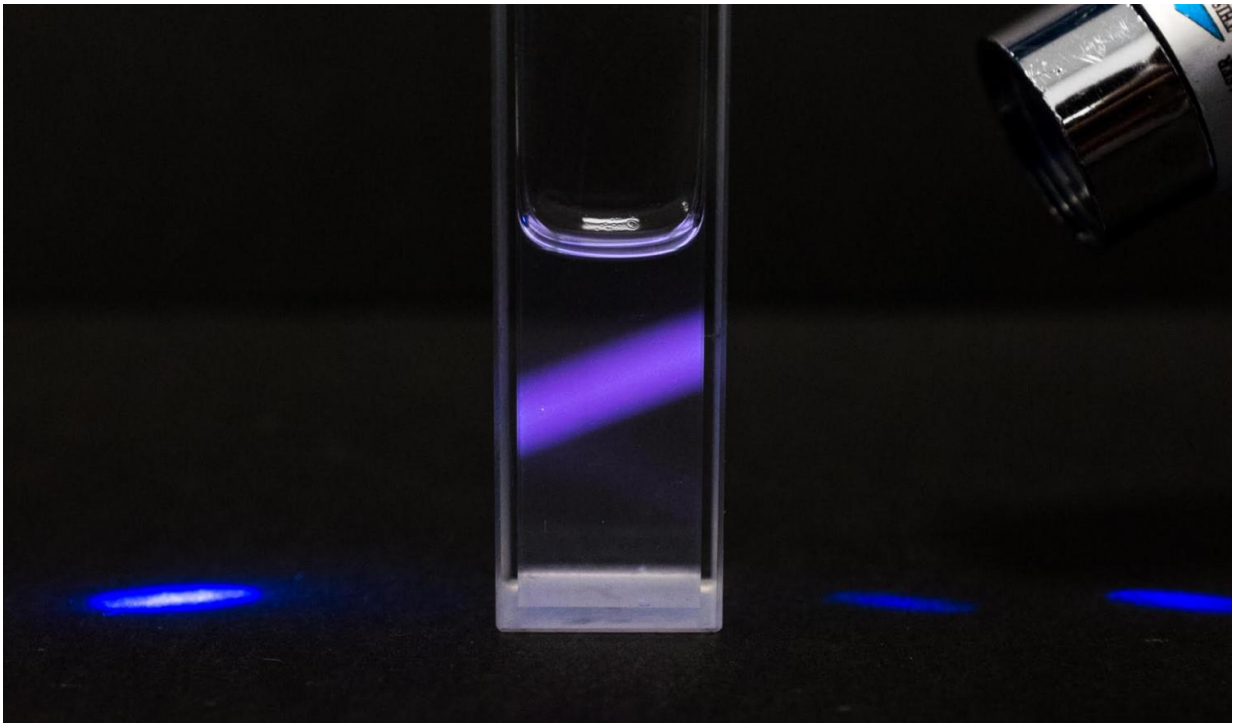


Chemists create nanoparticles for safe imaging of tumors

March 22 2017



A luminescent solution of nanoparticles. Credit: ITMO University

Chemists from Russia and Switzerland created biosafe luminescent nanoparticles for imaging tumors and blood vessels damaged by heart attack or stroke. The particles are made of hafnium oxide that is used for intravenous injection, and doped with ions of rare earth metals. The scientists hope to create an alternative to toxic quantum dots and image

deep tissues without harming the patient. The study appeared in *Colloids and Surfaces B: Biointerfaces*.

The scientists from ITMO University in Saint Petersburg and ETH Zurich sought to safely visualize cancer tumors and damaged blood vessels in the heart and brain. The nanoparticles they developed can emit visible light under ultraviolet and blue excitation that allows doctors to use them as a contrast agent for imaging internal tissues.

The imaging of organs is not illustrative without suitable markers, but all optically active substances used today for this purpose have significant drawbacks. Thus, organic agents do not work universally and rapidly disintegrate in the body. And although semiconductor nanoparticles called [quantum dots](#) have unique luminescent properties, because of their hazardous effect on a living patient, these particles can be used only in vitro.

According to ITMO scientists, the markers they've developed are free from these drawbacks and can replace quantum dots in the future. The new nanoparticles are composed of hafnium [oxide](#) doped with rare earth ions europium and terbium. They provide high luminescent properties and the hafnium oxide acts as a transparent matrix that ensures their biosafety and keeps them shining.

Hafnium oxide is bioinert; in 2015, the FDA included this substance in a list of oxides that are approved for internal use. Some forms of iron and aluminum oxides are also allowed for [intravenous injection](#). But unlike hafnium, they absorb too much light and weaken luminescence.



The luminescent solution of nanoparticles. Credit: ITMO University

In addition, hafnium and [rare earth metals](#) have atoms that are similar in size, so the chemists managed to keep the crystal oxide structure arranged when replacing a part of hafnium ions with the rare earth elements. This allowed the scientists to give the required optical properties to the nanoparticles, while preventing sedimentation in biological fluids of neutral pH.

The sedimentation of particles can accumulate and block [blood vessels](#). "We could not cover nanoparticles with a stabilizer, because it would reduce the quantum yield," says Aleksandra Furasova, the first author of the paper. "That is why we doped hafnium oxide with rare earth metal ions. Firstly, they charged surface of the particles that stabilized the latter in biological fluids. Secondly, introducing different rare earths, we learned to shift the luminescence spectrum. For example, particles with

terbium emit green, while particles with europium emit red. This will be useful for solving specific tasks."

Rare earth elements have a definite level of toxicity. So the chemists added large amounts of the particles to the samples of blood plasma and the medium with cultivated cells. It turned out that the particles are stable in blood and do not change their consistency; due to the ability of rare earth ions to be strongly bound in oxide, they do not harm cells.

Anna Fakhardo, a SCAMT researcher, adds, "For three days, we watched the life cycle of cultivated lung fibroblasts and mesenchymal stem cells and noticed no toxic effects caused by pure or doped nanoparticles of hafnium oxide. That is, they can be potentially applied in medicine."

In the future, the scientists are going to use [nanoparticles](#) of [hafnium oxide](#) not only for imaging, but for tumor therapy. Under X-rays, atoms of [hafnium](#) and rare [earth](#) metals, like all heavy elements, ionize water molecules that become so-called free radicals and begin to kill neighboring cells. This method of cancer treatment cannot compete with chemotherapy in price, but it is supposed to be less harmful because it allows treatment of tumors locally, even in the brain.

More information: Aleksandra D. Furasova et al, Synthesis of a rare-earth doped hafnia hydrosol: Towards injectable luminescent nanocolloids, *Colloids and Surfaces B: Biointerfaces* (2017). [DOI: 10.1016/j.colsurfb.2017.02.029](https://doi.org/10.1016/j.colsurfb.2017.02.029)

Provided by ITMO University

Citation: Chemists create nanoparticles for safe imaging of tumors (2017, March 22) retrieved 9

April 2024 from

<https://phys.org/news/2017-03-chemists-nanoparticles-safe-imaging-tumors.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.