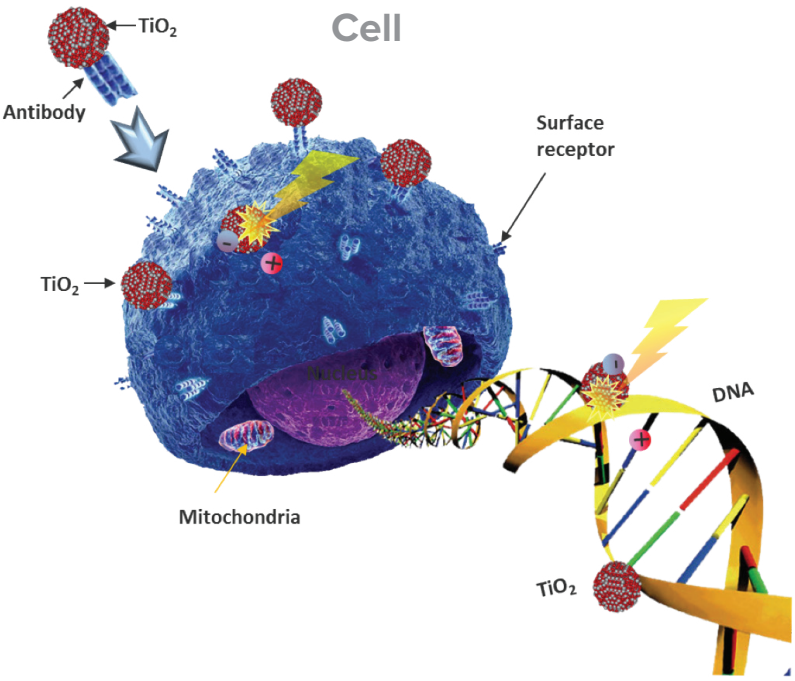
BIOLUMINESCENT SELF-POWERING NANOPARTICLES (IN-00-033)

Metal Oxide Semiconductor Nanoparticles Open the Door to New Medical Innovations, Including Killing Cancer with Light



Developmental Stage

- Antibody-targeted, light-induced, cancer-cell-killing *in vitro* and *in vivo* data are available.

Availability/ Commercial Readiness

- Ready for preclinical development with other selected cancer-recognizing antibodies.

THE INNOVATION

Scientists led by Tijana Rajh at Argonne National Laboratory's Center for Nanoscale Materials have developed novel nanometer-sized metal oxide semiconductors that allow researchers to target, initiate, and control *in vitro* and *in vivo* chemical reactions in biological molecules, such as DNA, proteins and antibodies. Rajh and her fellow researchers have discovered a technique that can covalently link biomolecules to specially designed inorganic nanoparticles. The unique inorganic-biomolecule interface acts as a "conductive wire," which can initiate chemical changes in the linked biomolecule and any complexes it may have formed with other biological macromolecules.

To demonstrate this technique, modified nanoparticles of the metal oxide semiconductor titanium dioxide (TiO_2) were synthesized and linked to a variety of biological molecules to produce a stable inorganic-biomolecule composite. The ability to create such a stable composite is important; it imparts stability and a high degree of specificity to the TiO_2 nanoparticles, allowing them to target and bind to many biological molecules—including DNA, RNA, proteins, and different cell surface receptors.

Once the nanoparticle-targeting biomolecule complex has bound to its selected biological target (e.g., a cancer cell), the light created by the complex elevates an electron from the valence band to the conduction band. The hole left behind in the valence band and the electron in the conduction band then become available for reactions with redox couples to undergo reduction and oxidation reactions in the vicinity. The redox active oxygen species (ROS) would create reactive radicals such as H_2O_2, O_2-, OH-, OCl-, and others, which activate programmed cell death, thus killing the targeted cancer cells.

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BENEFITS

The discovery of electronically linking TiO_2 particles with DNA and other biological molecules has opened the doors to many budding medical innovations. The hybrid nanoparticles have several potential commercial applications relating to their controllable dual "locate and destroy" function, including acting as synthetic DNA/RNA endonucleases. Research has also shown intracellular targeting of these nanoparticles, which could result in a groundbreaking tool for spatially and temporally controlled *in vivo* gene surgery and targeted cell metabolic intervention. Another intriguing application involves using the light-activated chemistries of the hybrid nanoparticles to prevent, control, and cure a variety of diseases.

PATENT INFORMATION

United States Patents 6,677,606 and pending patent applications

INVENTOR

Tijana Rajh

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CONTACT

Argonne Technology Development and Commercialization | 800.627.2596 | partners@anl.gov

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