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Plasmonic nanocrosses that heat up when illuminated can be used to kill cancer

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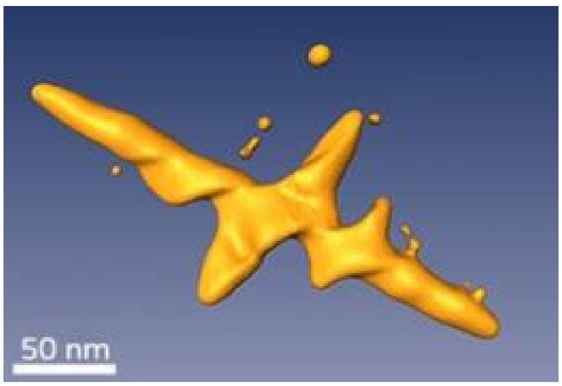

A reconstructed image of a gold nanocross surface. Credit: 2011 ACS

Plasmonic nanoparticles are extremely sensitive to light, and even the tiniest amount can cause these particles to heat up. Scientists are now trying to use plasmonic nanoparticles in cancer therapy whereby light energy is converted into heat in order to kill cancer cells. The advantage of such treatment is that it does not cause side effects that are common to chemotherapy. Mingyong Han at the A*STAR Institute of Materials Research and Engineering and co-workers have now developed gold plasmonic nanocrosses that are particularly suited to eliminating cancer cells in cancer therapy. The team demonstrated the usefulness of these nanocrosses by using them to kill human lung cancer cells.

In general, metallic nanostructures have a particular frequency at which light excites electrons close to their surface. The collective movement of electrons, or resonance, in the metal is what converts the light energy into heat. The wavelength at which the resonance occurs is strongly dependent on the size and shape of the nanostructures.

For biomedical applications, the nanostructures should be effective no matter which direction they are illuminated from. Furthermore, the nanostructures should be efficient in absorbing near- to mid-infrared wavelengths because tissue is transparent to the light of these wavelengths.

Based on these requirements, the researchers decided to make gold nanocrosses (see image). In normal synthesis, however, gold would usually grow into the shape of the nanorods. To fabricate nanocrosses, the researchers added copper ions to the growth solution. The incorporation of small amounts of copper caused a twinning of the gold's crystal structure, which in turn led to the growth of side arms from the crystal facets. "The unique cross-shaped gold structure enables multi-directional excitation to achieve a strong plasmonic resonance in the near- and mid-infrared region. This greatly lowers the laser power required for photothermal cancer therapy compared to nanorods," says Han.

The researchers tested the performance of their gold nanocrosses by modifying their surfaces and binding them to human lung cancer cells. When irradiated with near-infrared laser light of relatively modest powers of 4.2 W/cm^2 for 30 seconds, all cancer cells were killed. The researchers are now planning to test the effectiveness of the gold nanocrosses on animal models in future experiments.

Other applications of the gold nanocrosses are also possible, including photothermal imaging, in which small amounts of light are converted into local heat, or the sterilization of surfaces. "In our current research, we are studying gold nanocrosses for the photothermal destruction of superbugs on biofilms," says Han.

More information: Research article in the Journal of the American Chemical Society

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