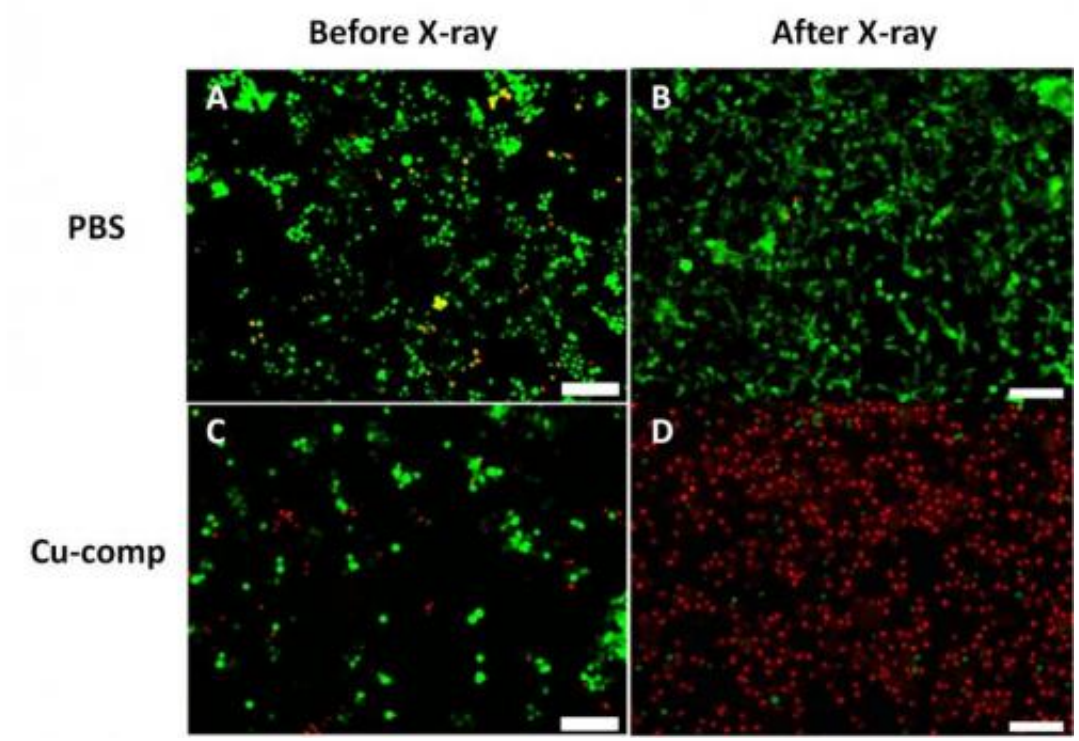
Physicists create new nanoparticle for cancer therapy

April 16 2014



This figure from the paper shows the X-ray destruction of human breast cancer cells using Cu-Cy particles. The images show the live cancer cells stained green and the dead cells stained red. Credit: Wei Chen/UT Arlington

A University of Texas at Arlington physicist working to create a luminescent nanoparticle to use in security-related radiation detection may have instead happened upon an advance in photodynamic cancer therapy.

Wei Chen, professor of physics and co-director of UT Arlington's Center for Security Advances Via Applied Nanotechnology, was testing a copper-cysteamine complex created in his lab when he discovered unexplained decreases in its luminescence, or light emitting power, over a time-lapse exposure to X-rays. Looking further, he found that the nanoparticles, called Cu-Cy, were losing energy as they emitted singlet oxygen – a toxic byproduct that is used to damage cancer cells in photodynamic therapy.

Because Chen also is leading federally funded cancer research, he knew he had found something unique. Testing revealed that the Cu-Cy nanoparticles, combined with X-ray exposure, significantly slowed tumor growth in lab studies.

"This new idea is simpler and better than previous photodynamic therapy methods. You don't need as many steps. This material alone can do the job," Chen said. "It is the most promising thing we have found in these cancer studies and we've been looking at this for a long time." Chen's research is being published in the August edition of the *Journal of Biomedical Nanotechnology* under the title "A New X-Ray Activated Nanoparticle Photosensitizer for Cancer Treatment." Co-authors are Lun Ma, a research assistant professor, and Xiaoju Zou, a research associate.

The University has also filed a provisional patent application on the new complex.

Photodynamic therapy, or PDT, harms cancer cells when a photosensitizer introduced into tumor tissue produces toxic singlet oxygen after being exposed to light. In some studies, this light exposure is done through use of visible or near-infrared lasers. Others have found more success by also introducing luminescent nanoparticles into the tumor. Researchers activate the luminescent nanoparticle with near-infrared light or X-rays, which in turn activates the photosensitizer.

Both methods have limitations for treating deep tissue cancers. They are either inefficient or the light source needed to activate them doesn't penetrate deep enough. Chen said that X-ray inducible Cu-Cy particles surpass current photosensitizers because the X-rays can penetrate deep into tissue. Also, Cu-Cy nanoparticles don't need other photosensitizes to be effective so the treatment is more convenient, efficient and cost-effective.

"Dr. Chen's commitment to his work in cancer-related therapy, as well as his work in the area of homeland security, demonstrates the wide-ranging applications and great value of basic science research," said Carolyn Cason, vice president for research at UT Arlington. "These advances have the potential to change the way some cancers are treated and make therapy more effective – a benefit that would be boundless."

Chen's team tested the Cu-Cy on human breast and prostate cancer cells in the lab and found it to be an effective treatment when combined with X-ray exposure. In one test, for example, a tumor treated with Cu-Cy injection and X-ray exposure stayed virtually the same size over a 13-day period while a tumor without the full treatment grew by three times.

Another advantage of the new nanoparticle is a low toxicity to healthy cells. In addition, Cu-Cy's intense photoluminescence and X-ray luminescence can be used for cell imaging, the paper said.

Details of the crystal structure and optical properties of the new complex are being published in an upcoming paper from the *Journal of Materials Chemistry*. It is available here. Chen continues to pursue photodynamic cancer therapy research under a grant from the Department of Defense Congressionally Directed Medical Research Programs and with collaborations from industry. He said further research would include reducing the size of the Cu-Cy nanoparticle to make it more easily

absorbed in the tumor tissue.

"For cancer, there is still no good solution yet. Hopefully this nanoparticle can provide some possibilities," he said.

Provided by University of Texas at Arlington