Life Science

Innovative Strategy in Nanomedicine for Targeted Cancer Therapy: Laser-triggered nanoplatform enabling site-specific drug delivery

Targeted cancer therapy opens up a new idea for the treatment of tumor. Due to its unique size effects, nanomedicine can take advantage of the enhanced permeability and retention effect (EPR) to preferably accumulate in tumor tissue after systematic administration. To further improve this targeting efficacy, some targeting ligands are often attached on the surface of nanomedicine. It is expected that these ligands can recognize and bind to the target for active targeting therapy. However, *in vivo* performance of many ligand-modified tumor-targeted nanoparticles is not as good as initially envisioned, because ligand attachment often decreases their blood circulation time and ligand affinity to receptors instead of altering their biodistribution. External stimuli such as ultrasound and magnetic field have also been applied to trigger *in vivo* tumor targeting. Locally applied external heating can also induce site-specific accumulation of intravenously injected thermal-responsive polymers and their payloads. These novel tumor-targeting strategies could be very efficient to enhance the selectivity of certain effects since the timing and intensity of the stimuli can be precisely controlled.

Drs. CHEN Chunying and WU Xiaochun's group

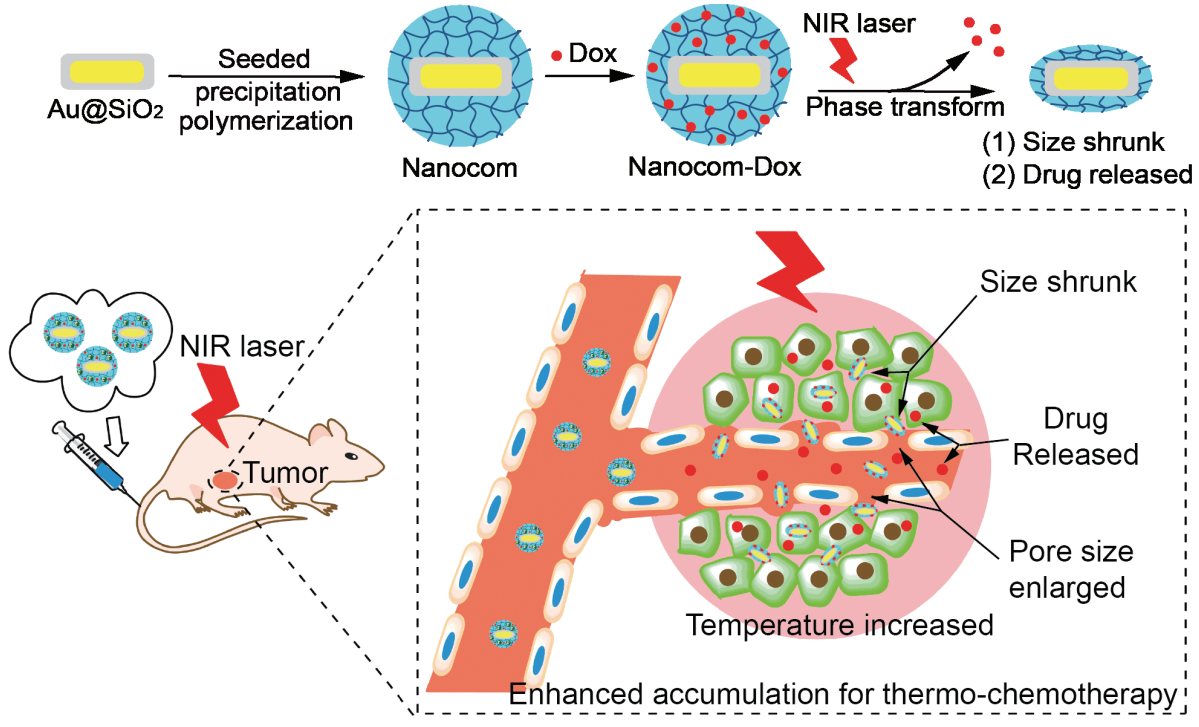

Figure 1: Schematic illustration of the nanocomposite formulation process and NIR laser induced targeting thermo-chemotherapy using the nanocomposite.

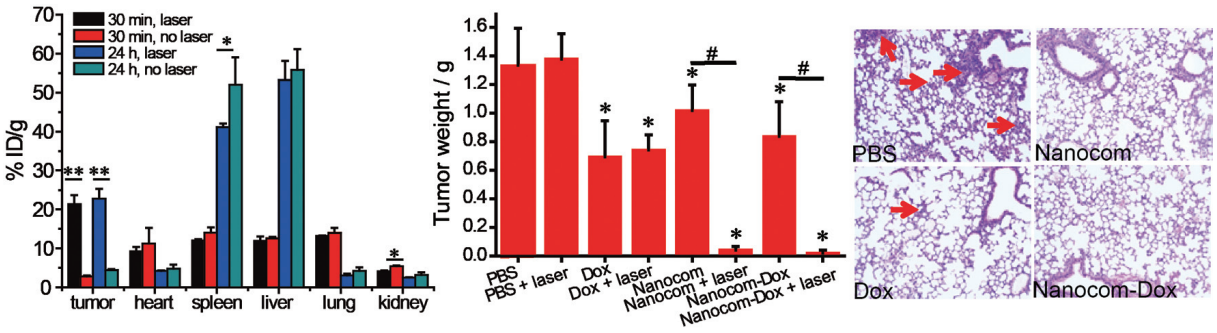

Figure 2: Tumor accumulation of the nanocomposite with NIR laser irradiation and synergistic thermo-chemotherapy of Dox loaded nanocomposite, which effectively inhibited the growth and metastasis of tumor.

at the National Center for Nanoscience and Technology of China have been working closely on the bio-effects and safety studies of gold nanorods, and their biomedical applications as well. In previous studies, they developed a core-shell nanostructure, mesoporous silica coated-gold nanorods (Au@SiO_2) for laser controlled tumor therapy in cell lines. The chemotherapeutic drug can be efficiently loaded into the mesopores of Au@SiO_2 and the release can be controlled with laser irradiation.

The two groups have proceeded to coat a thermo-responsive polymer onto the surface of Au@SiO_2 and developed a thermo-responsive nanocomposite, Au@SiO_2@polymer, for laser-targeted tumor therapy. After systematic administration and irradiation on the tumor by near-infrared laser, the vascular permeability of tumor was increased induced by local elevated tumor temperature, and the size of nanocomposite was shrunk which made it easier to extravagate from tumor vessels. These two synergistic effects made the nanocomposite much more accumulated in the tumor tissue than that without laser irradiation. In this nanocomposite, the photothermal properties of gold nanorods and the thermo-responsive properties of polymer were successfully integrated and realized laser induced tumor active targeting (Figure 1). The tumor accumulated nanocomposite showed synergetic thermo-chemotherapy which almost achieved inhibition of tumor growth and metastasis (Figure 2).

Since laser can be manipulated very precisely and flexibly, the nanocomposite provides an ideally versatile platform to simultaneously deliver heat and anticancer drugs in a laser-activation mechanism with facile control of the area, time, and dosage. The NIR laser-induced targeted cancer thermo-chemotherapy represents a novel anti-cancer targeting strategy with simple control and practical efficacy.

These results were published in the *Journal of American Chemical Society* (*J. Am. Chem. Soc*. 2014, 136, 7317–7326). One of the reviewer said: "The system of the active accumulation of the nanoparticles and the controlled release of Dox responding to light irradiation are interesting and will be promising technique for multimodal cancer treatment."

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