Biofunctionalized multifunctional nanoconstructs based upconverting $NaYF_4$ doped rare earth and magnetic Fe_3O_4 nanoparticles for theranostic applications.

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The main goal of our research was to create multifunctional nanoconstructs based on two kinds of nanomaterials. We synthetized up-converting nanoparticles (UCNPs) of yttrium sodium fluorides and superparamagnetic iron oxide nanoparticles coated by silica.

The UCNPs based on β-$NaYF_4$ with a hexagonal structure doped with Yb^{3+} and Er^{3+} ions exhibit visible luminescence (green and red) after near infrared (980 nm) laser excitation. The nanoparticles were functionalized by photosensitizer (Rose Bengal), and the energy transfer from nanoparticles to the dye was observed. The Rose Bengal produced the reactive oxygen species (ROS), which resulted in the 4T1 breast cancer cells death. This construct can be used to photodynamic therapy (PDT) for cancer treatment.

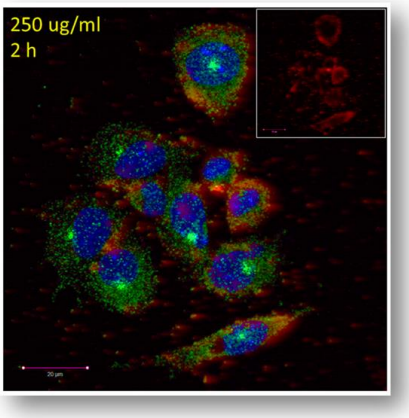

Fig. 1 UCNPs-RB nanoconstruct inside 4T1 breast cancer cells after 980 nm of excitation. Blue – nuclei; green – lysosomes, red – nanoparticles.

The other kind of UCNPs– $NaYF_4$ doped with Tm^{3+} and Yb^{3+} ions– irradiated by 980 nm light convert this radiation to visible and ultra violet light. At the same time thanks to high energy generated light (UV) in aqueous environment UCNPs generate ROS which are toxic for cancer cells. This kind of nanoparticles do not need photosensitizer for PDT cancer treatment.

This kind UCNPs were biofunctionalized by antihuman-IgG antibody (UCNPs@SiO_2-PEG-AntiH:IgG) which can be attached to the human-IgG on the cells surface. This type of

nanoparticles can be used in molecular targeting therapy, and after ROS generation for targeting PDT.

Another group of nanoparticles prepared by us was superparamagnetic Fe_3O_4 doped by Y^{3+} ions. The hyperthermia effects were measured as a function of Y^{3+} amounts inside Fe_3O_4. The intrinsic loss power factor was determined. The Fe_3O_4 nanoparticles were introduced into 4T1 breast cancer cells which were destroyed in magnetic hyperthermia. The Fe_3O_4 nanoparticles can be used in targeted therapy by using an external magnetic field. They can also cause an contrast increase in magnetic resonance imaging (MRI).

Combining PDT with hyperthermia treatment in one nanoconstruct will allow for a more efficient cure of patients than offered by the currently used modalities.

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