Radiolabeled Magnetic AMF-Responsive Nanoparticles as Gamechangers in Cancer Therapy

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Hybrid nanoparticles are currently receiving a lot of attention in the biomedical sciences due to their ability to express multiple modalities in one entity. One attractive application of such multifunctional materials is the development of theranostic agents for simultaneous imaging and therapy of cancer. Of particular interest are superparamagnetic iron oxide nanoparticles, which after being introduced into the tumor tissue, can directly respond to an alternating external magnetic field (AMF) by generation of heat. The heating capacity translates into the local temperatures that can be reached in tumors, ranging from hyperthermia (41-46 °C) to thermal ablation (>46 °C), sparing the healthy organs. Additionally, the high magnetic moment of the iron oxide nanoparticles alters the transversal relaxation time of protons of water in the surrounding tissues, generating a T_2 (dark) contrast in magnetic resonance imaging. Combined, these magnetic properties [1] enable image-guided thermal treatment of tumors, while addition of a radioisotope into the nanoparticle's core envisions a system for thermo-brachytherapy – a novel therapeutic strategy.

Here we present nanoparticles composed of palladium-103 core and iron oxide shell (Figure 1A) that respond to AMF (50-750 kHz, 15-30 mT) with specific power loss up to 225 W/g (Figure 1B), sufficient for thermal ablation of tumors (15 cm^3). Palladium-103 ($t_{1/2}$=17d), with its low-energy X-rays (21 KeV) derived from the electron capture decay, is well-suited for delivering a radiotherapeutic dose to eradicate the remaining cancer cells. We emphasize the importance of specific synthetic design [2], incl. radiolabeling and surface functionalization, to drive the desired functional outcome and demonstrate the first in vitro proof-of-concept results.

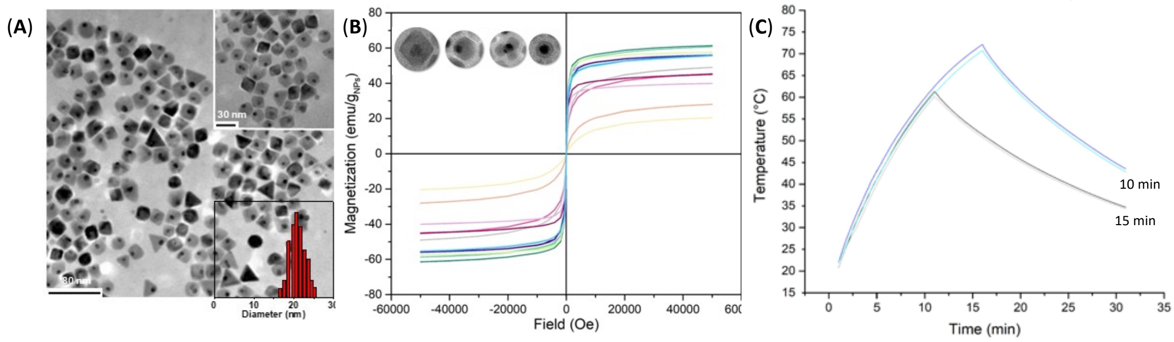

Figure 1. Palladium-103/iron oxide hybrid nanoparticles: (**A**) TEM images of the core-shell structures; (**B**) SQUID curves representing the magnetic behavior of various morphologies; (**C**) Heating profiles of square-shaped analogues upon exposure to AMF for 10 and 15 min.

References

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