DESCRIPTION FOR THE GENERAL PUBLIC

Controlled and deliberately induced in the human body temperature rise, above the physiological body value of 36.6°C but not exceeding 45°C, is called hyperthermia. Today, owing to the development of technology, the desired temperature rise in tissues can be achieved by various methods, including ultrasonic waves or alternating magnetic field. In both cases, the externally supplied energy (acoustic or magnetic) is absorbed by the tissues and in consequence converted to thermal energy - heat. Thermal procedure - hyperthermia, is used in medicine as a method supporting anti-cancer therapies. The temperature rise in body results in increased vessel permeability and blood oxygenation, which is helpful for chemotherapy and radiotherapy.

The efficiency of thermal procedures can be improved and optimized. The effectiveness of ultrasonic hyperthermia can be improved by materials that increase scattering and wave absorption, which in turn will induce additional temperature increase. As a scattering material nanoparticles of gold, silicon or as I propose in my research project magnetic nanoparticles, covered with a suitable layer to ensure the biocompatibility of the material, can be used. The effectiveness of magnetic hyperthermia can be improved by simultaneous interaction with ultrasonic waves. This will increase the thermal efficiency of the Brown effect, which is partially responsible for the temperature rise in the magnetic hyperthermia. The temperature increase caused by the absorption of ultrasonic waves will allow to easier movement of magnetic nanoparticles, which due to the viscosity friction will also become a source of heat.

The proposed project concerns investigation of the thermal effect of magnetic hyperthermia influenced by ultrasound sonication. More specifically, my research will include experiments on temperature rise, in a function of time and magnetic material, during simultaneous interaction of ultrasound on the magnetic field. Research will also include the determination of acoustic properties of tissue mimicking materials after doping them with scattering material. In conclusion, the proposed project will explore physical phenomena, whose effect will expand knowledge about the influence of nanomaterials on the effectiveness of thermal therapies and knowledge about the synergy of both types of hyperthermia. Similar attempts to combine these methods have not been described in detail, so far.

The foundation for this project was laid by thorough fundamental studies, conducted during my master degree, which I am also currently pursuing at PhD studies. The research focuses on the field of nanomaterials and nanomedicine that can support cancer treatments, which is now a source of great interest. Some of the results related to this subject of my research have already been published and can be found here: https://doi.org/10.1063/1.4955130 (Applied Physics Letter, 2016).