Engineering a Low-Cost Environment for Magnetic Hyperthermia: From Nanoparticle Synthesis to Alternating Magnetic Field Testing

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Magnetic Hyperthermia (MH) is a targeted cancer therapy utilizing magnetic nanoparticles and alternating magnetic fields (AMFs) to induce heat via Néel and Brownian Relaxation. Despite the potential that MH has as a noninvasive treatment for cancer, more research is necessary to optimize the procedure, but the research ability is limited by the cost of the equipment used for experimentation. This project investigates a low-cost method of experimentation, including nanoparticle synthesis, a self-developed instrument to characterize nanoparticles, and MH testing on phantom tissues. Magnetite nanoparticles were successfully synthesized via coprecipitation with Sodium Hydroxide. The optical properties were characterized with a UV-Vis spectrum that confirmed that the particles had similar properties. A low-cost Dynamic Light Scattering (DLS) instrument was also designed and fabricated to compare the sizes of different samples of particles. Thermochromic phantom tissue was designed to test the effects of MH, but the initial setup involving a coil was unsuccessful, as the magnetic field generated by the coil was weak due to the insufficient current supplied by the function generator. Consequently, the project pivoted to using a motorized rotating magnetic field that alternated the field at a rate of 1kHz. This was successful in producing an average temperature increase of 0.8 plus or minus 0.2 ? in 15 minutes. The actual clinical procedure is expected to use a higher frequency AMF for more pronounced results. The project was successful in developing low-cost methods of experimenting with MH for a budget under $200. This setup can be used to conduct research on the factors that affect Specific Absorption Rates with the goal of further optimizing the procedure for MH.

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