Utilizing Magnetic Nanoparticles to Advance MRI-based Hyperthermia Abilities

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Research question: Is it possible to utilize magnetic nanoparticles and MRI systems to generate and guide Hyperthermia throughout the body?

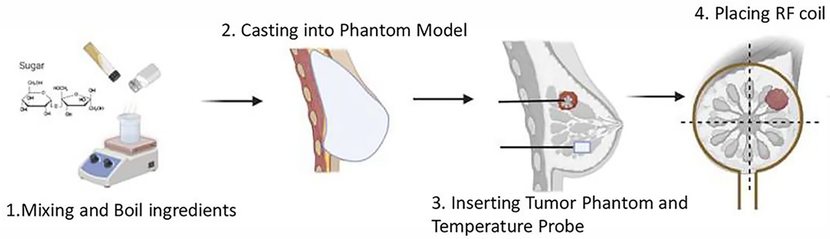
Introduction and Motivation

Magnetic nanoparticles (MNPs) represent tiny particles capable of inducing artificial hyperthermia when subjected to a magnetic field. This ability, upon reaching a sufficiently high temperature, can effectively trigger cell apoptosis within the human body, thereby minimizing the necessity for invasive procedures. Such a feat would be leading solutions towards many cell obstructions such as cancer, mutations, and other issues.

This research aims to find characteristics of biocompatible metals such as Iron and Graphene as MNPs. The primary objective is to find the maximum range and area of effect that temperature modulation via artificial hyperthermia can achieve.

Methods

For this project, the making of breast and tumor models consisted of sugar, salt, and agar, with ingredients set to match the permeability and conductivity of a breast model [3]. All coils made throughout the process were tuned to 178 MHz and placed on both the breast and tumor models. From which temperature probes were inserted.



Data and Analysis

Small Scale Results

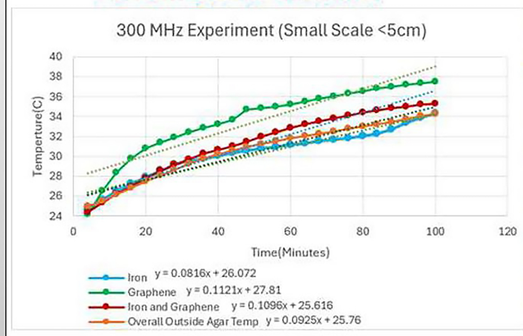


Fig.1 Nanoparticle's Change in Temperature in Small Container

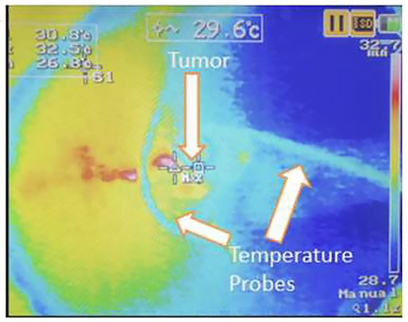


Fig.2 Infrared View of Breast Model and Tumor

Large Scale Results

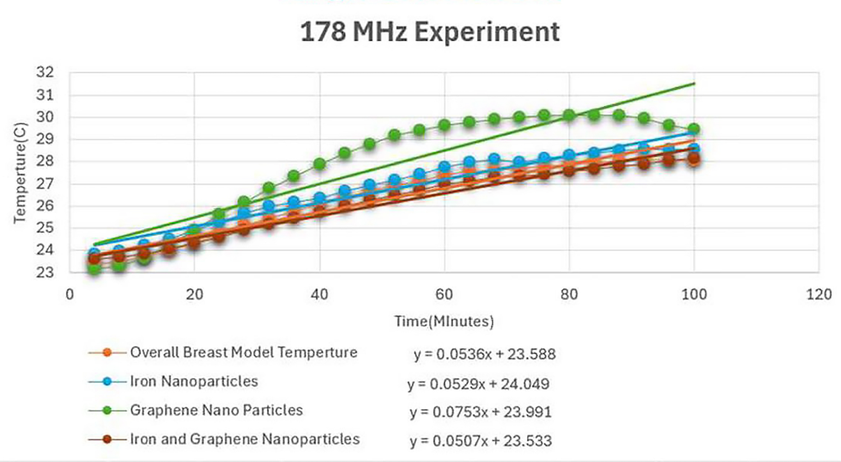


Fig.3 Nanoparticle's Change in Temperature comparted to Breast Model

Conclusion and Discussion

As indicated by the results, graphene exhibited the highest temperature accumulation with iron and the combination of at comparable rates to those observed with the breast model. This suggests that for larger models, such as a breast tumor, nanoparticles associated with heat conduction, such as graphene, play a significant role. This outcome was anticipated, as evidenced by earlier findings on a smaller scale, where graphene demonstrated the most significant temperature change. With these findings in mind, it is anticipated that both large-scale and small-scale experiments can be correlated for tumors of varying sizes, with the temperature for apoptosis nearly reaching 43°C.

Future Work

RF hyperthermia is a new concept that has solid groundwork to work and become useful in the future with new ideas in research testing drug delivery, artificial cell apoptosis, and radiotherapy[4].

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