Magnetic Hyperthermia based Cancer Treatment

Mehak[1], Lalit M. Pandey[*]
Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Assam, India
mehak1998@iitg.ac.in
*Corresponding author Email: lalitpandey@iitg.ac.in

Cancer is one of the fatal non-communicable diseases and the number of cases is on the rise, worldwide. GLOBOCAN 2020 estimated 19.3 million new cases and 10 million deaths due to cancer in the year 2020. Over the last years, research in the field of cancer treatment has been expanded. Besides having lots of research going on in this field, getting an appropriate cure for cancer is still a challenge. Traditional therapies including chemo-, radio- therapy and surgery are the main treatments available to treat cancer but are associated with severe side effects. Also, immunotherapy is at the developing stage. Tumour is hard to eliminate completely because these cells show drug resistance, metastasis and mutations. There is therefore a surge to find an effective and least invasive cure. In this direction, nanotechnology has advanced the medicine and biomedical fields. Nanomedicine is a promising approach for effective treatments of different diseases including cancer. Nanoparticles possess excellent physical properties such as small size/high surface area to volume ratio, heating capacity (in the case of magnetic nanoparticles) and their unique multifunctional features of stimulus/stimuli-responsiveness. Hyperthermia is thus being studied. Magnetic nanoparticles are excellent candidates for magnetic particle mediated hyperthermia (MPH) or magnetic field hyperthermia (MFH), in which temperature is raised above the normal body temperature (42-48 °C) under the influence of an externally applied alternating magnetic field (AMF). This elevated temperature is considered as the hyperthermia temperature which is safer for the normal tissues to quite a good extent but is able to ablate the tumour tissues.

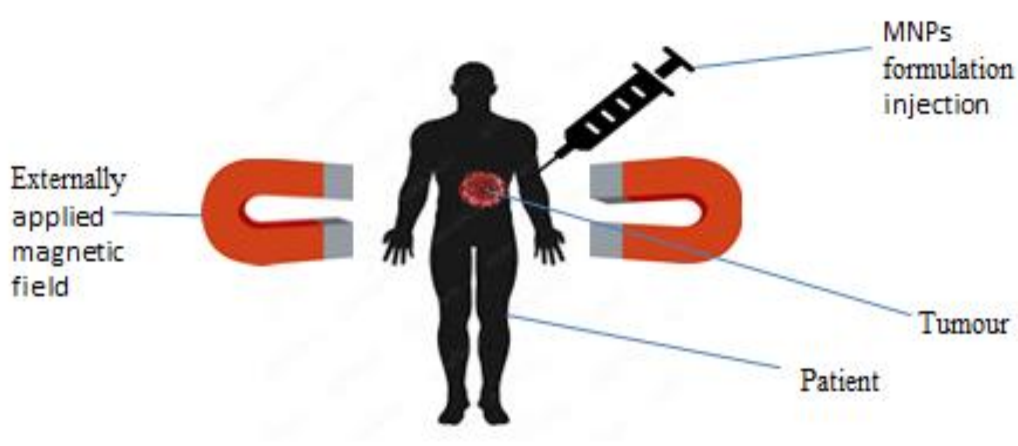

Figure 1: Diagrammatic representation of Magnetic Hyperthermia

Keywords: magnetic hyperthermia, superparamagnetic iron oxide nanoparticles, cancer treatment

At present times, hyperthermia is being evolved in which hysteresis and relaxation losses are used to generate heat. For practical applications, its potential along with other therapeutic approaches such as chemotherapy and radiotherapy are being exploited. The chemotherapy/radiotherapy sensitizes the tumour cells for further thermal therapy and thus the synergic effect of the combined therapies leads to an enhanced tumour-cell death.

In this regard, Iron oxide nanoparticles (IONPs) because of their excellent and tunable magnetic properties are intensively explored. They are biocompatible, less toxic and physio-chemically stable and thus are being investigated for different biomedical applications. Superparamagnetic iron oxide nanoparticles (SPIONs) possess desired magnetization values and the heating ability for hyperthermia applications. Magnetization saturation and specific absorption rate (SAR) values mainly regulate the heating ability of nanomaterials in the applied alternating magnetic field. Yet, there are few challenges towards its practical applications. The recent advancements in nanotechnology have enabled the tuning of the physical, chemical and biological properties.

The objective of this study was to analyze the effect of varying reaction temperatures on the synthesis of magnetite nanoparticles and their characteristics. We have synthesized magnetite (Fe_3O_4) nanoparticles at various temperatures (35-65 °C, at an interval of 10°C). The as-prepared magnetite nanoparticles were characterized by vibrating sample magnetometer (VSM) and X-ray diffraction (XRD). VSM analysis graph is shown in Figure 2. 45 °C was found to be the optimum temperature for the synthesis of magnetite nanoparticles.

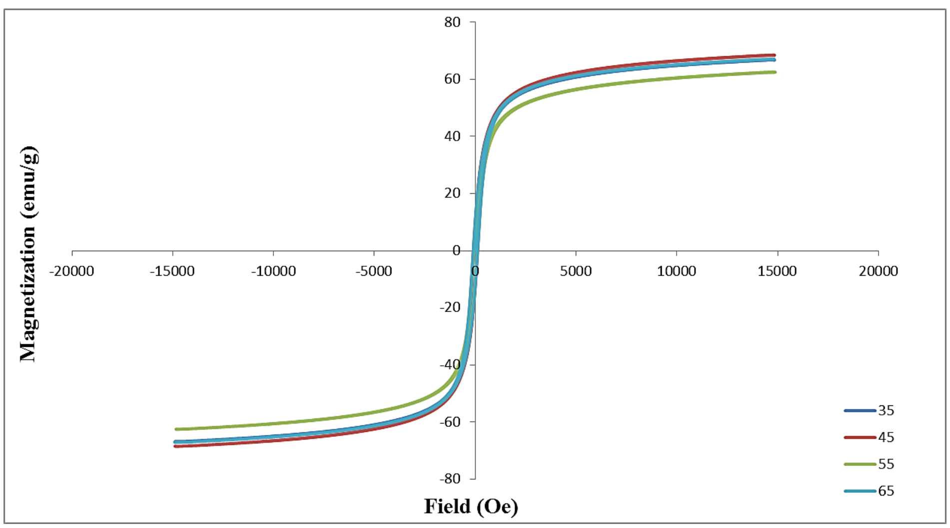

Figure 2: VSM graph of prepared Fe_3O_4 nanoparticles synthesized at different temperatures

`

References

Tsopoe, S.P., Borgohain, C., Fopase, R., Pandey, L.M., Borah, J.P.: A comparative investigation of normal and inverted exchange bias effect for magnetic fluid hyperthermia applications. Scientific Reports. 10, (2020).

Reyes-Ortega, F., Checa Fernández, B.L., Delgado, A. v., Iglesias, G.R.: Hyperthermia-triggered doxorubicin release from polymer-coated magnetic nanorods. Pharmaceutics. 11, (2019).

Jamir, M., Islam, R., Pandey, L.M., Borah, J.P.: Effect of surface functionalization on the heating efficiency of magnetite nanoclusters for hyperthermia application. Journal of Alloys and Compounds. 854, (2021).