Controlled Drug Release and Targeted Drug Delivery Using an AC Magnetic Field System

Delivery of drugs in response to external stimuli or after a period of time is known as controlled drug release, and delivery of drugs to a particular location within a system is known as targeted drug delivery.

The usual routes of medicine delivery, whether drug, protein/peptide, vaccine, or gene based, are oral, topical, nasal, sublingual, vaginal, ocular, rectal and inhalation. However, these conventional delivery routes often present hurdles, such as enzymatic degradation and non-specific absorption.

Controlled and targeted drug release improve drug efficacy and safety, and facilitate target specificity. This is especially valuable in complex medical treatments, which are important.

Controlled Drug Release

Stabilized magnetic nanoparticles can be functionalised with thermally labile groups to which drugs can be linked. When these surface-functionalised magnetic nanoparticles are exposed to an alternating magnetic field using the magneTherm™ from nanoTherics, the particles dissipate through Neel and Brownian relaxation. In response to the dissipated heat, the thermally labile linking group disintegrates or breaks, and releases the drug [1,2](Figure 1).

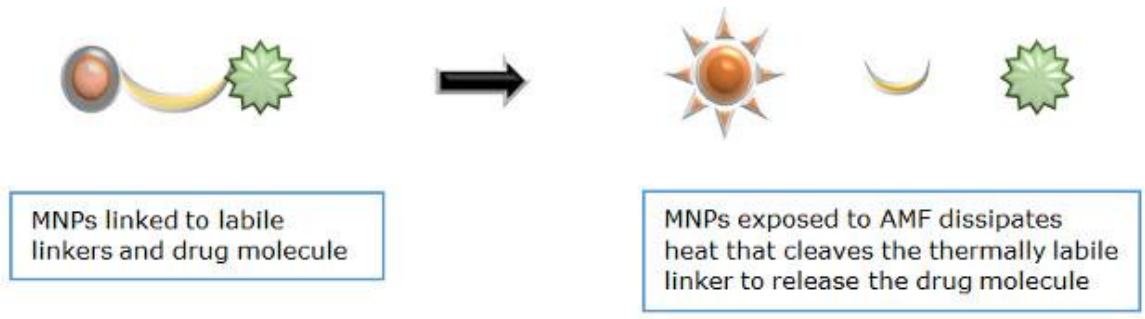

Figure 1. *AMF triggered controlled drug delivery system*

magneTherm™ user Dr. Teresa Pellegrino and her group (Istituto Italiano di Tecnologia, Italy) have demonstrated a similar AMF-triggered drug release system, by surface functionalizing iron oxide nanoparticles with a thermolabile azo group linking to a chemotherapeutic drug, in this case (e.g. doxorubicin).

The cytotoxicity assay showed a promising decrease in viability of KB cancer cells with this AMF triggered drug release system. It is also possible to introduce slowly disintegrating thermolabile linkers, for slow release of drugs or prolonged exposure to a certain dosage of drugs.

magneTherm™ facilitates these studies as the SAR value increases at increasing frequency in a constant field amplitude.

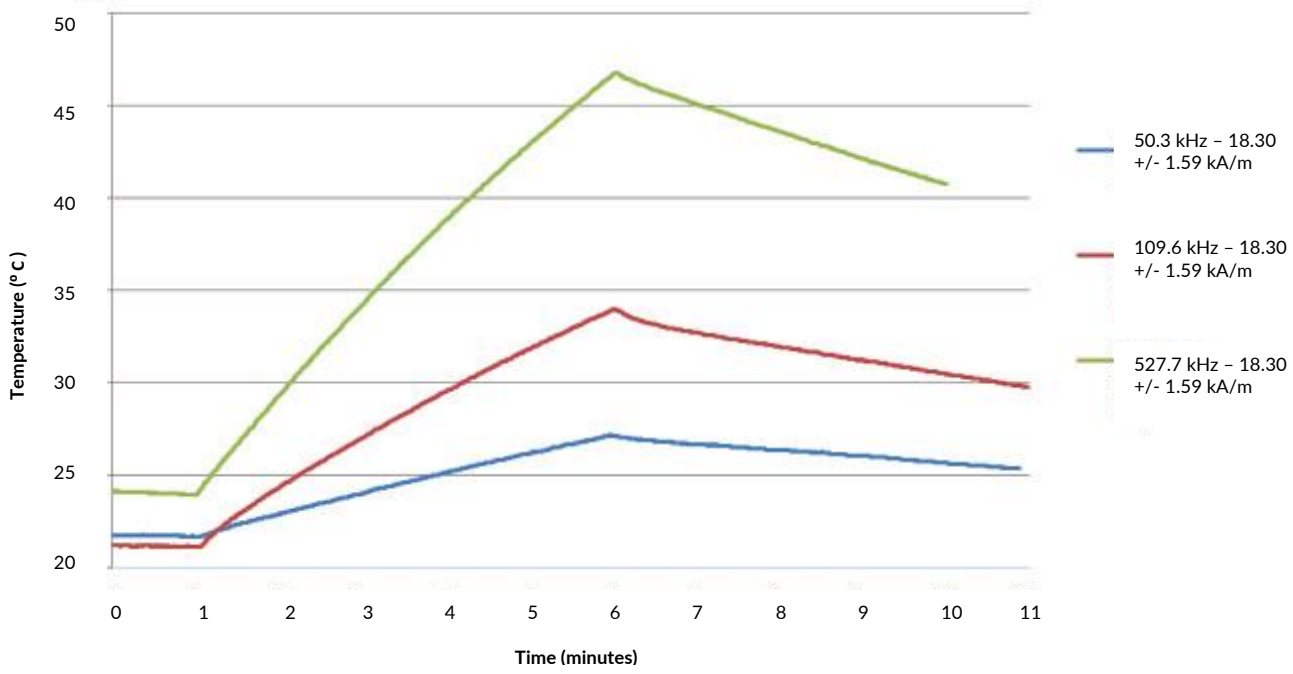

Figure 2. *magneTherm study showing increasing SAR with increase in temperature. Test sample: 11nm magnetite in citrate-stabilized aqueous suspension.*

Targeted Drug Delivery

Magnetic nanoparticles can be coated with drugs and surface functionalised with a monoclonal antibody to a specific antigen expressed on the tumour cells within an organ. When the functionalized nanoparticles are administered, they attach to the relevant antigens on the tumour surface – then, once the tumour cells endocytose these nanoparticles, the drug is delivered into the tumour (Figure 3).

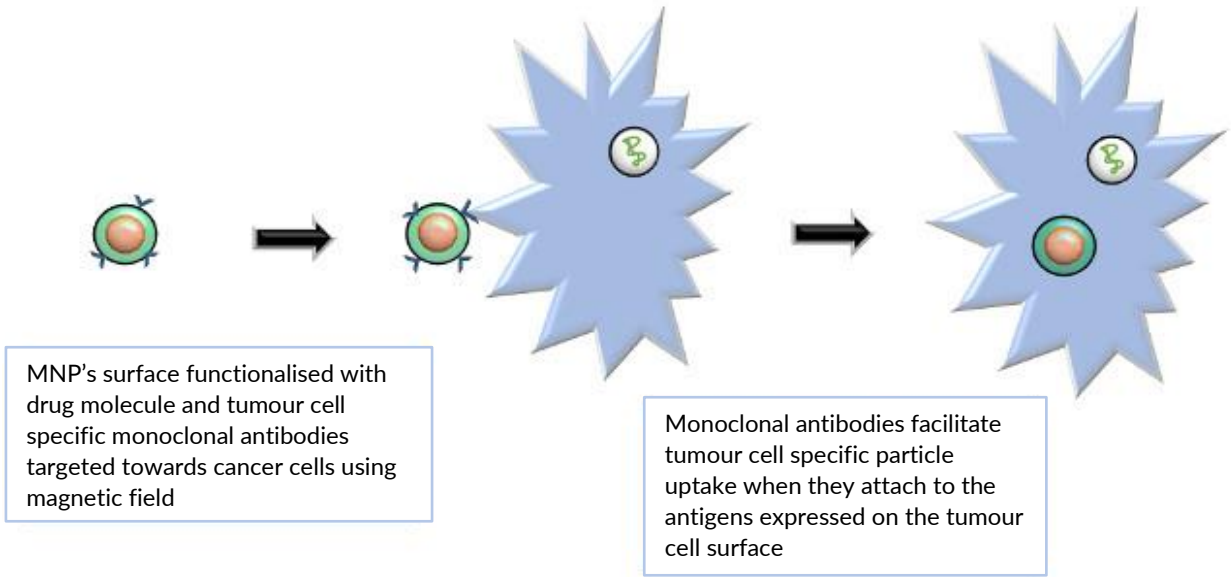

Figure 3. *Magnetic nanoparticle mediated targeted drug delivery*

Magnetic nanoparticles attached to the drug through a heat-sensitive linker can be manipulated externally into the specific target region using a strong magnetic field.

When subjected to an alternating field using the magneTherm, the linker will disintegrate to release the drug into the system [3,4].

References

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2. Ioanna Savva, Andreani D. Odysseos , Loucas Evaggelou, Oana Marinica, Eugeniu Vasile , Ladislau Vekas , Yiannis Sarigiannis, and Theodora Krasia-Christoforou., 2013. Fabrication, Characterization and Evaluation in Drug Release Properties of Magnetoactive poly (ethylene oxide)-poly(L-lactide) Electrospun Membranes. Biomacromolecules, DOI: 10.1021/bm401363v

3. Jon Dobson., 2006. Magnetic nanoparticles for drug delivery. Drug Development Research. Special Issue: Nanobiotechnology. Vol 67, 1, 55–60

4. Beata Chertok, Bradford A. Moffat, Allan E. David, Faquan Yu, Christian Bergemann, Brian D. Ross, and Victor C. Yang., 2008. Iron Oxide Nanoparticles as a Drug Delivery Vehicle for MRI Monitored Magnetic Targeting of Brain Tumors. Biomaterials. February; 29(4): 487–496.

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