



## Adarsh Sandhu and Hiroshi Handa (Editors): Magnetic nanoparticles for medical diagnostics

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This was one of the most interesting, and one of the most difficult to read books I've ever read! It is not really a book in the normal sense but a series of loosely related articles on Magnetic Nanoparticles, each separately referenced. This is not uncommon in scientific publishing, and not necessarily a Bad Thing.

The first chapter is a fairly straightforward description of using magnetic nanoparticles for sentinel lymph node detection as an alternative to Lymphoscintigraphy, quite easy to follow for a Nuclear Medicine Physicist. So far it looks good, easy to read and related to my work in medical physics.

Straight after this, in Chapter 2, we are smashed into hard-core cellular biology and the separation in solution of different parts of the chopped up cells (via “osmotic shock” or “tissue grinder”), such as mitochondria and endosomes, using attachment of magnetic nanoparticles. Next chapter, we are building magnetic nanobeads that attach to DNA sequences or bioactive compounds and allow identification of their targets.

An example of such a bioactive compound is capsaicin, the active ingredient that makes chillies hot. Capsaicin binds to and activates the “transient potential cation channel sub-family V member 1 (TRPV1)” which we use to detect body temperature, and “induces sensations of excessive heat or abrasive damage”. This technique has revealed another target protein for capsaicin which leads to capsaicin-induced cell death in cancer cells. Similarly interesting stories are told for Vitamin K and Salicylate (Aspirin precursor).

Amazing stuff, but for a physicist, even one who minored in organic chemistry, it is tough going with numerous

undefined acronyms and biochemical terms, I only really understood about five out of ten of them.

Chapter 4 heads back into the “diagnostics” suggested by the book title, finding a way of speeding up the reading of bioassays by concentrating the bound molecules/antigens by attaching fluorescent magnetic nanobeads. Chapter 5 discusses “surface modified magnetic nanoparticles” which are coated with capsid (virus shell) proteins, and can then be put into the bloodstream to collect in target cells, where they could be imaged with MRI, or heated with time varying magnetic fields in what they call “anti-cancer thermal therapy”. One randomly selected page of this chapter contained 86 acronyms and there were 6 pages of references at the end of this chapter alone...

Chapter 6 expands on the previous therapeutic idea to discuss “Magnetic hyperthermia treatment”, which is done by introducing “heating mediators” that “emit heat in an alternating magnetic field” into the lesion to “locally heat the cancer only”. Here the physicist is back in familiar territory, with a series of equations showing the eddy current losses, hysteresis energy, and then interesting effects that occur with small particle sizes like Néel and Brown rotation. Plenty of graphs such as “Figure 6.9 shows the specific loss power (SLP) of monodisperse magnetite against a particle's diameter” made me feel at home again. The chapter then goes on to describe trials of this treatment in real people, heating implants, and an applicator for the alternating magnetic field.

Chapter 7 moves completely away from “medical” and “diagnostics” starting off as a chemistry primer in how to make magnetic oxide or metal particles, and how to create a magnetic fluid: “Iron-cobalt carbonyl was prepared by dissolving 255.2 mM of iron carbonyl and 63.8 mM of cobalt carbonyl in 500 mL of tetrahydronaphthalene and stirring the same for 72 h at room temperature”. A few equations on magnetic interactions between the particles, specifically to avoid aggregation, which would change the effective particle

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size, bring us back into physics land, but because magnetic fluids are so cool, we can forgive the chemical recipes—or maybe we might be tempted to try them at home—just need to find that spare bottle of argon... The chapter then suggests applications of the magnetic nanoparticles produced, but these have already been discussed at length in the earlier chapters.

Chapter 8 is a discussion of detection methods for magnetic particles, including a cool magneto-optical sensor which makes use of magnetic particle self-assembly into chains in a magnetic field. It then moves onto making microcoils to manipulate the particles to make a biosensing platform which can be used to eliminate non-specific interactions and was shown by the authors to be able to detect biotin (a B-complex vitamin which currently has no good laboratory test).

Aside from some strange things like images in a paper book of the first frame of a video (URL link also provided), the book is clear and well written, with good English, if very, very hard to read in parts due to the content. The title is a bit misleading, several chapters have nothing to do with medical diagnostics, but if you are interested in everything (like all physicists would be) then I would hope you'd find it as interesting as I did—with the proviso that you really have to grind your way through the verbiage!

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