Influence of The Medium Viscosity on Superparamagnetic Nanobeads Heating Power

Rousseau, Alice (School: Lycee Polyvalent Marie-Louise Dissard Francoise)
Marin, Lucille (School: Lycee Polyvalent Marie-Louise Dissard Francoise)
Tellier, Marine (School: Lycee Polyvalent Marie-Louise Dissard Francoise)

Ferromagnetic nanoparticles placed in a high frequency alternating magnetic field (AMF) release heat. When used to locally increase body temperature over 37°C, this phenomenon is called magnetic hyperthermia and one of its possible applications is killing cancerous cells, which are viscous medium. Our study focuses on the influence of the medium viscosity on the heating power of magnetic nanobeads (MNBs), quantified by the Specific Absorption Rate (SAR). SAR was determined by measuring the area of hysteresis loops obtained with a pick-up coils device, used on two sizes of MNBs placed in agarose solutions. Three different SAR behaviors are observed as agarose content (i.e. viscosity) rises: (i) SAR first drops to a minimum value for both MNBs sizes, (ii) Interestingly and only for smaller MNBs, after going through a minimum, SAR increases again towards a steady value, (iii) For bigger MNBs, SAR remains constant after reaching its minimum value. These can be explained as follow: (i) both MNBs fail to form chains, (ii) smaller MNBs spin around less easily as viscosity rises, (iii) bigger MNBs can no longer spin around for the used AMF frequency. Viscosity seems to greatly impact MNBs heating power. It leads to questioning the representativity of SAR measurements in water for nanoparticles intended for biological applications. AMF frequency and MNBs size also appear to be decisive factors. As for hyperthermia, our results entail a potentially promising use of nanobeads as a relevant choice for the AMF frequency could overcome the effects of viscosity on their heating power.

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