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MagnetoTheranostics RTD 2013

FNSNF

From superparamagnetic nanoparticles to cancer detection and treatment

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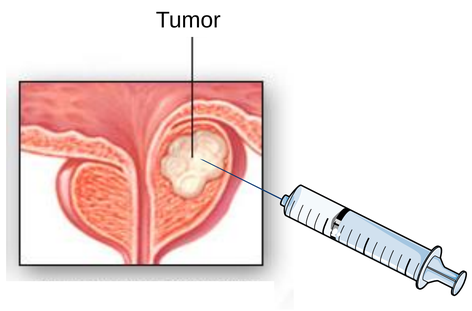
Introduction

Superparamagnetic iron oxide nanoparticles (SPIONs) can dissipate heat when exposed to an alterning magnetic field. In contact with human tissue, this heat can be used to elevate the temperature of the surrounding cells (**hyperthermia)**. Reaching a threshold temperature of 42° C, apoptosis of cells will be provoked. The aim of the project is to locally deliver SPIONs into prostate tumor for hyperthermal **tumor treatment**.

Prostate cancer

shows the third highest mortality of cancerous diseases (WHO) in men in Europe, especially in elderly patients. The optimal therapy scheme is controversial, since common treatments like radical prostatectomy are accompanied by significant risks of decreased quality of life.

Route of administration



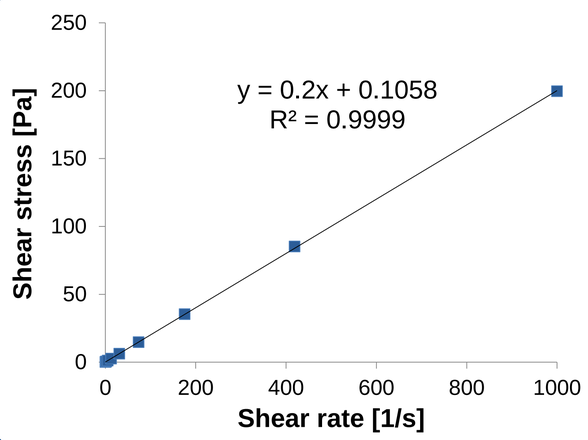
Minimally invasive injection of a **liquid nanocomposite formulation** solidifying as a semisolid implant upon contact with body fluids.

Formulation

SPIONs embedded in mesoporous silica (**silica-SPION-beads**) and suspended in a radiopaque solution of mono-/tri-iodo benzoate polyvinylalcohol in DMSO.

Radiopacity of the polymer is required in vivo for real- time monitoring of implant distribution using X-ray imaging.

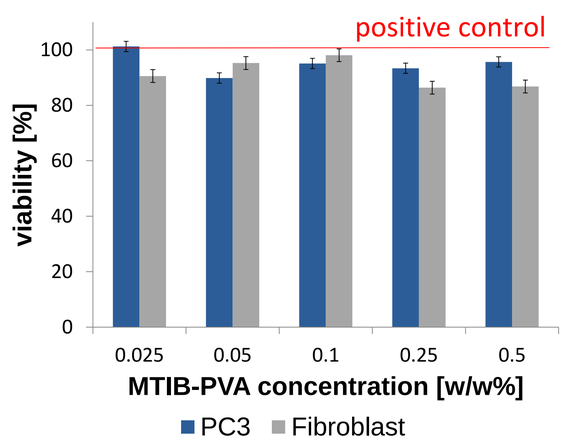
Characterization



Rheology

A **low viscosity** of 200mPa*s and **Newtonian behaviour** ensure an appropriate syringeability of the injectable formulation for clinical use.

Figure 1: Rheological behaviour of the liquid nanocomposite



In-vitro cytotoxcity

No cytotoxicity of MTIB-PVA was observed on PC3 cells (prostate cancer cells) and fibroblasts (healthy cells).

Figure 2: The cell viability measured by WST-1 after an exposure time of 48h.

Microstructure

An exemple of a **silica-SPION-bead** is shown in *Fig. 4 A* with a mean size of 11,35±1,68µm determined by laser diffraction analysis.

Fig. 4 B is revealing the homogeneous microporous structure of the pure **MTIB-PVA implant** after precipitation and solvent exchange.

Silica-SPION-beads entrapped in MTIB-PVA implant also lead to a microporous structure (*Fig. 4 C)*.

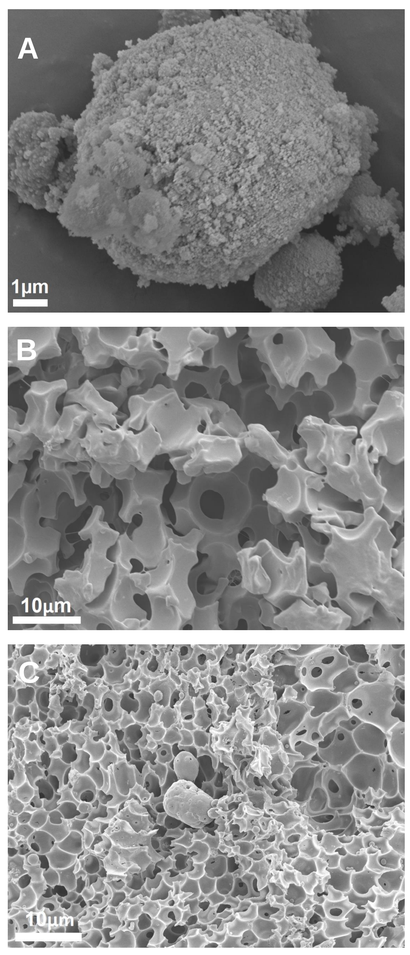
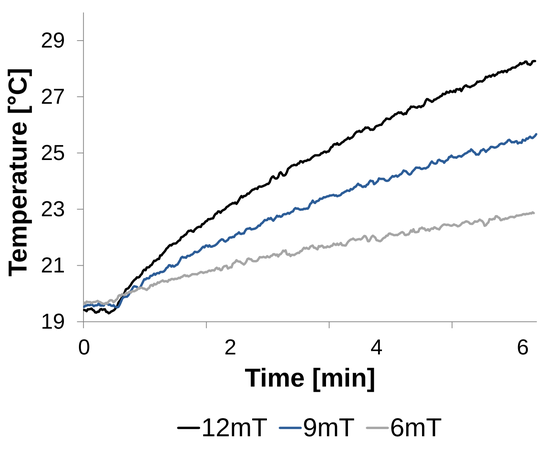


Figure 4: SEM pictures of silica-SPION beads (A), solidified MTIB-PVA implant (B) and silica-SPION beads entrapped in MTIB-PVA implant (C)



Heating measurements

An implant-induced temperature increase up to 7° C was measured, expected to locally induce cell death.

Figure 3: Temperature increase of implant exposed to alterning magnetic fields at 122kHz.

Conclusion

The formulation of silica-SPION-beads suspended in a radiopaque polymer solution shows an **adequate syringeability** and forms a **porous, homogeneous gel-like implant** upon contact with aqueous solutions.

Entrapping a sufficient amount of silica-SPION-beads, the precipitated implant is able to **dissipate heat.** Consequently, the in-situ forming nanocomposite holds promise for **local tumor thermotherapy**.

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