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Development of magneticresponsive poly(ε-caprolactone) nanoparticles with potential applications in advanced cancer therapeutics

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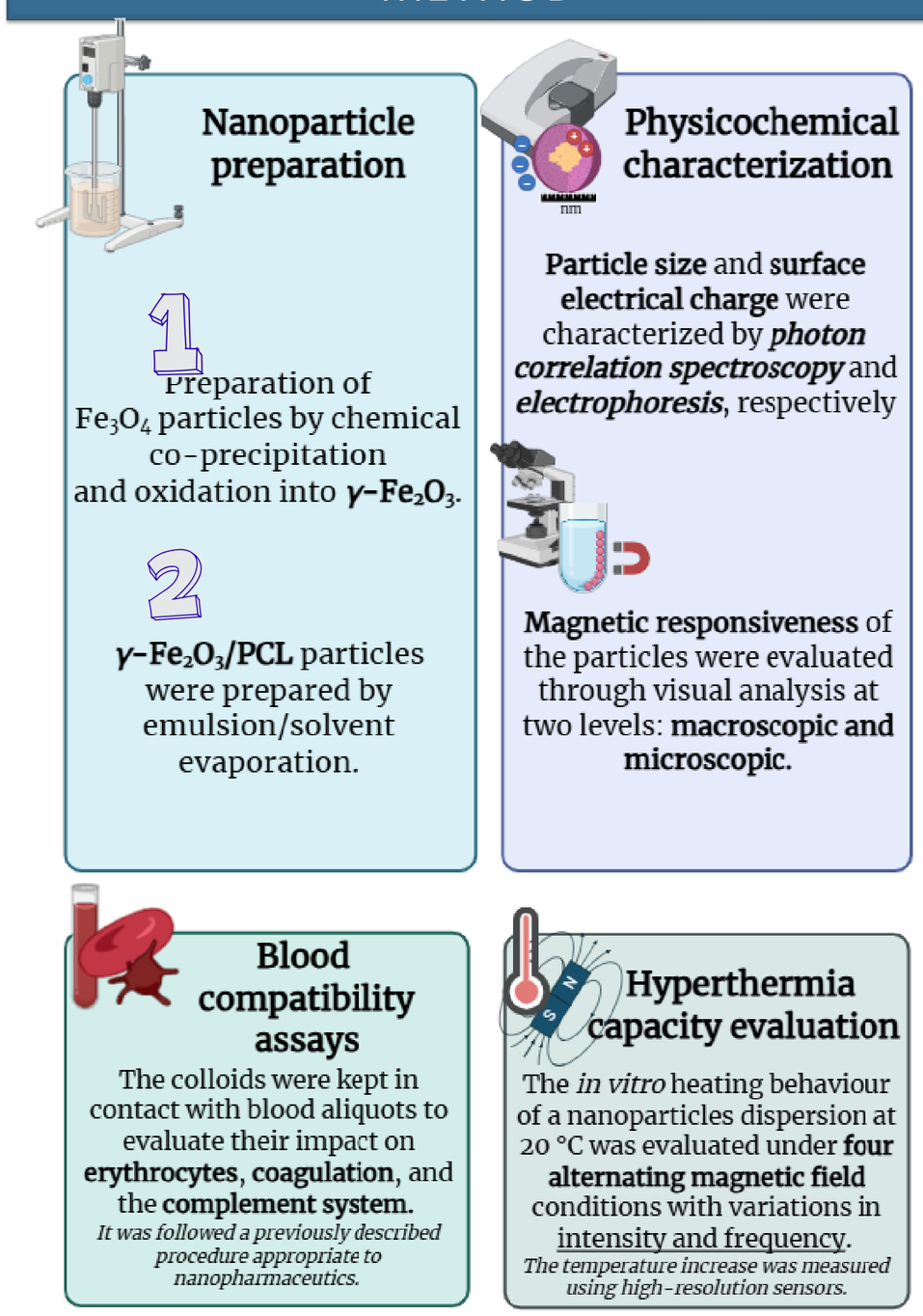
INTRODUCTION & AIM

Cancer continues to be a major global health challenge and remains one of the leading causes of mortality. Early diagnosis and targeted treatment are essential, but often limited by insufficient precision and specificity. In this context, pharmaceutical nanotechnology has emerged as a promising field, offering significant advances in cancer diagnostics and therapy. Among the nanomaterials being investigated, iron oxides have garnered considerable interest due to their favorable magnetic properties and versatile biomedical applications.

The aim of this work was to define a reproducible procedure to formulate haemocompatible maghemite/poly(ε-caprolactone) (γ-Fe_2O_3/PCL) nanoparticles (NPs) with potential applications against cancer.

METHOD



RESULTS & DISCUSSION

1 The γ-Fe_2O_3/PCL nanocomposites were in the **colloidal range** (370 ± 30 nm).

2 Electrokinetic analysis confirmed the **successful formation of the core/shell structure** (*Figure 1*).

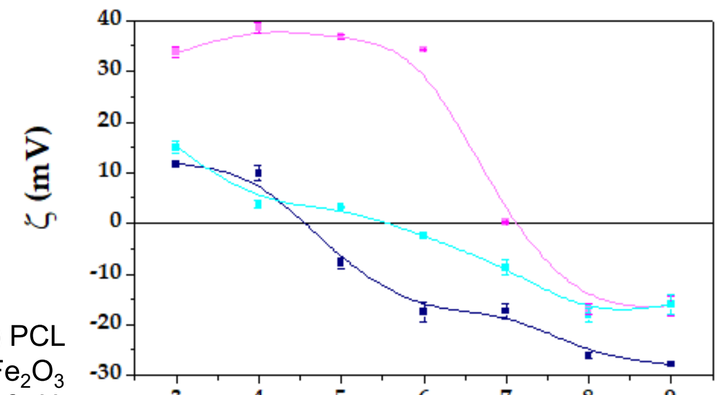


Figure 1. Zeta potential (ζ, mV) of (■) PCL NPs, (■) γ-Fe_2O_3 NPs, and (■) γ-Fe_2O_3 /PCL NPs as a function of pH.

3 **Negligible effect of NPs** on haemolysis, platelet activation (sP-selectin release), complement system activation (C3a desArg), and plasma clotting time ($T_{1/2}$ max) (*Table 1*).

Sample	Haemolysis (%) Incubation time 4 h	Haemolysis (%) Incubation time 48 h	sP-selectin release (ng/mL)	C3a desArg (ng/mL)	$T_{1/2\ max}$ (min)
γ-Fe_2O_3 /PCL	1.1 ± 0.6	1.2 ± 0.5	104 ± 2	317 ± 9	11.8 ± 1.9
Control (PBS solution)	0	0	103 ± 3	303 ± 6	10.2 ± 2.7

Table 1. *Ex vivo* blood compatibility of the γ-Fe_2O_3 /PCL NPs.

4 In addition, the nanohybrids demonstrated **favorable magnetic responsiveness** (*Figure 2*) and **heating capacity** (*Figure 3*). The experiment showed ΔT^a above 38 ºC depending on the applied frequency. This suggests that, starting from 37 ºC, minimum antitumour hyperthermia temperature (≈ 41ºC) could be easily reached. It was confirmed that the exposure time depends on the frequency.

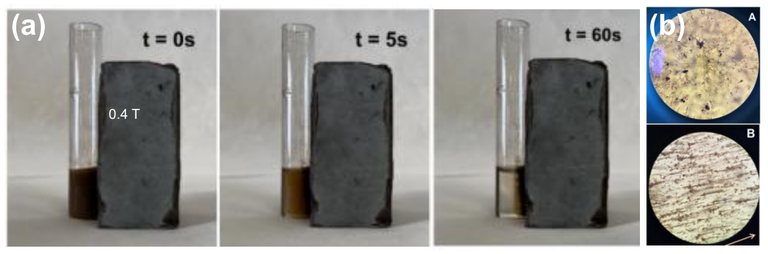


Figure 2. Macroscopic (a) and microscopic (b) visual analysis of the magnetic responsiveness of NPs exposed to a static (a) and moving (b) magnet.

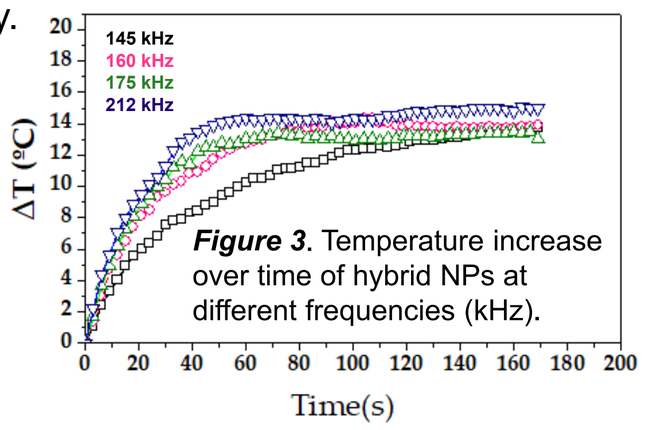


Figure 3. Temperature increase over time of hybrid NPs at different frequencies (kHz).

CONCLUSION

The γ-Fe_2O_3/PCL nanohybrids may enable magnetic-driven accumulation into the site of action and, probably, multifunctional capabilities for cancer therapy.

REFERENCES

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