(Para)magnetic Hybrid Nanocomposites for Dual MRI Detection and Treatment of Solid Tumours

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Abstract

Cancer is the second leading cause of death worldwide, with approximately 18.1 million new cases and 9.6 million deaths in 2018.[1] Current treatment protocols (surgery, chemo-, radio- and immuno-therapy) have proved their utility in the clinic; nevertheless, they are unspecific resulting in low efficiency and severe side effects. Therefore, we have developed an innovative tool against solid tumors through a combination of early diagnosis and treatment (theranosis), that aims to reduce systemic toxicity. We have synthetized a hybrid nanocomposite including iron oxide (Fe_3O_4) and manganese oxide (MnO) magnetic nanoparticles (NPs) dispersed in a lipid matrix [2]. The chemotherapeutic drug, Doxorrubicin was encapsulated in the lipid matrix (Fig.1). The lipid matrix allows the direct delivery of the drug to cells while the magnetic core allows the generation of heat under an alternating magnetic field (magnetic hyperthermia, MH), which enhances drug release from the nanocomposite. Furthermore, magnetic nanoparticles are ideal contrast agents (CAs) for MRI, allowing the early and non-invasive imaging of tumors [3]. The nanocomposite was characterized in terms of physico-chemical and functional properties, with a focus in its performance as an MRI contrast enhancer, MH effector and controlled drug delivery system. *In vitro* experiments to validate this (para)magnetic nanocomposite in Hs578T cell were also performed [2]. The resulting hybrid nanocomposite present a size of ~170 nm with a zeta potential of 29 mV. The particles exhibited great magnetic properties, which translated into a good dual T_1-T_2 behavior in MRI. The r_1 and r_2 relaxivity values were 13 and 318 mM^{-1} s^{-1}, respectively, which is higher than commercially available CA formulations. *In vitro* studies showed that cells presented a reduced viability when Doxorubicin was encapsulated, which indicates that encapsulation potentiates its effect. We also observed a reduced cell viability when cells were treated with the nanocomposite combined with MH induction, indicating a higher drug release.

REFERENCES

[1] International Agency for Research on Cancer – World Health Organization, Estimated age-standardized incidence rates (World) in **2018**, all cancers, both sexes, all ages.
[2] Vieira Rocha, C., Costa da Silva M., *ChemComm* **2020**, 56, 8695-8698.
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FIGURES

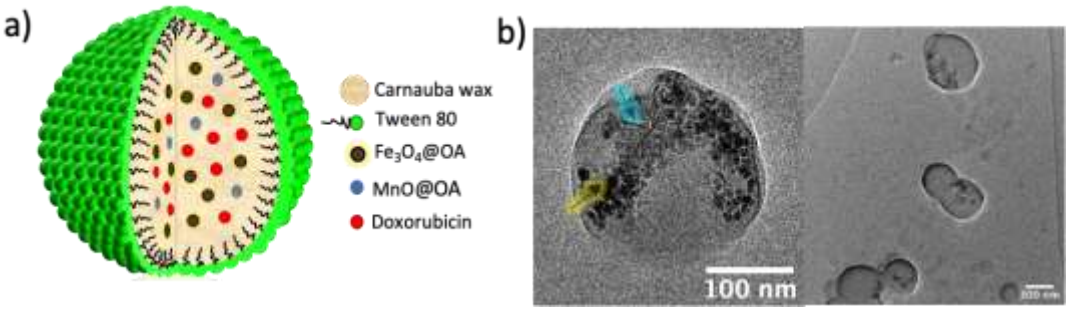

Figure 1: (a) Schematic representation of the hybrid nanocomposite and (b) respective TEM images (blue arrows highlight MnO NPs, yellow arrows highlight Fe_3O_4 NPs).