FERRITIN-COATED SPIONS AS A SMART MAGNETIC NANOCARRIER FOR SITE TARGETED THERANOSTIC APPLICATIONS

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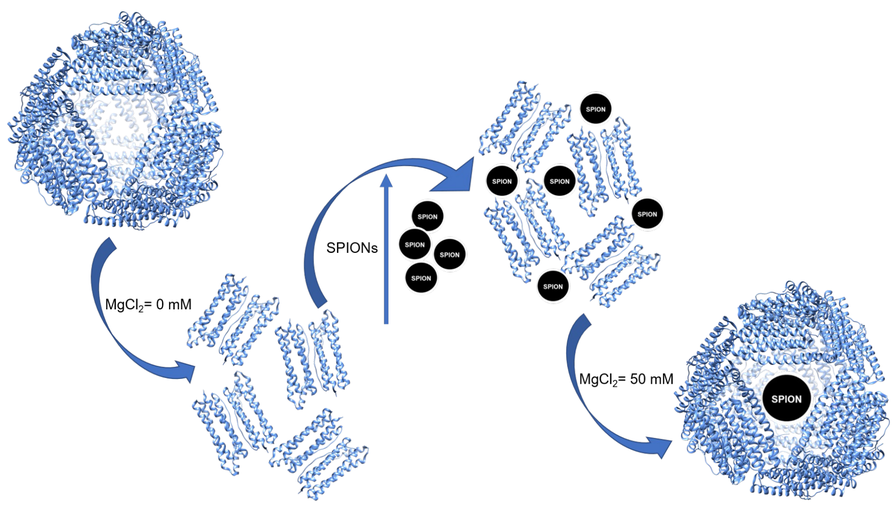
INTRODUCTION AND AIMS

- The versatility of the Superparamagnetic Iron Oxide Nanoparticles (SPIONs) allows the production of theranostic and multifunctional devices that can be used for simultaneous drug delivery and imaging (Licciardi et al., 2019).
- For the first time, ferritin coated SPIONs were investigated as nanotools for site targeted theranostic applications. We used the Humanized *Archaeoglobus fulgidus* ferritin (HumAfFt) as a coating material for 10 nm SPIONs, in order to create a new magnetic nanocarrier able to discriminate cancer cells from normal cells and maintain the potential theranostic properties of SPIONs (Affatigato et al., 2023).
- Thanks to the salt-triggered assembly mechanism and to the 24-mer typycal structure of HumAfFt, SPIONs were successfully coated with the HumAfFt. We used different biophysical techniques to characterize the HumAfFt-SPIONs and to study their properties. Size and morphology of the new complex were determined by TEM analysis. Circular dichroism (CD) showed that SPIONs changed the secondary structure of HumAfFt. Magnetic properties of HumAfFt-SPIONs and uncoated SPIONs were investigated by electron paramagnetic resonance (EPR) technique. To gain further insight in the HumAfFt-SPIONs, the thermal dependence of magnetization was studied by comparing zero field cooling (ZFC) and field cooling (FC) data of uncoated SPIONs and HumAfFt-SPIONs.

MATERIALS AND METHODS



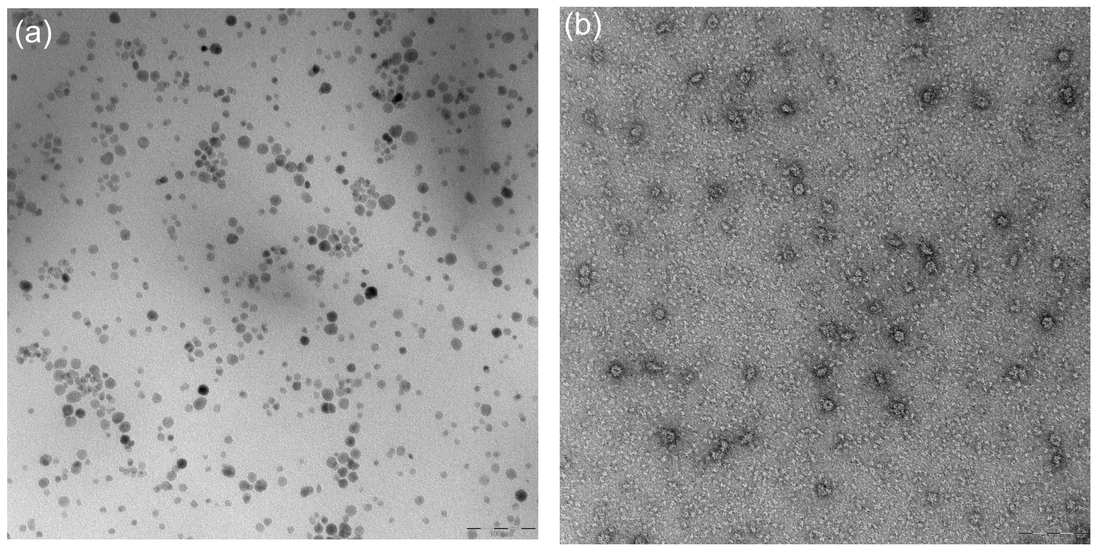
- Schematic illustration of HumAfFt-SPIONs preparation.

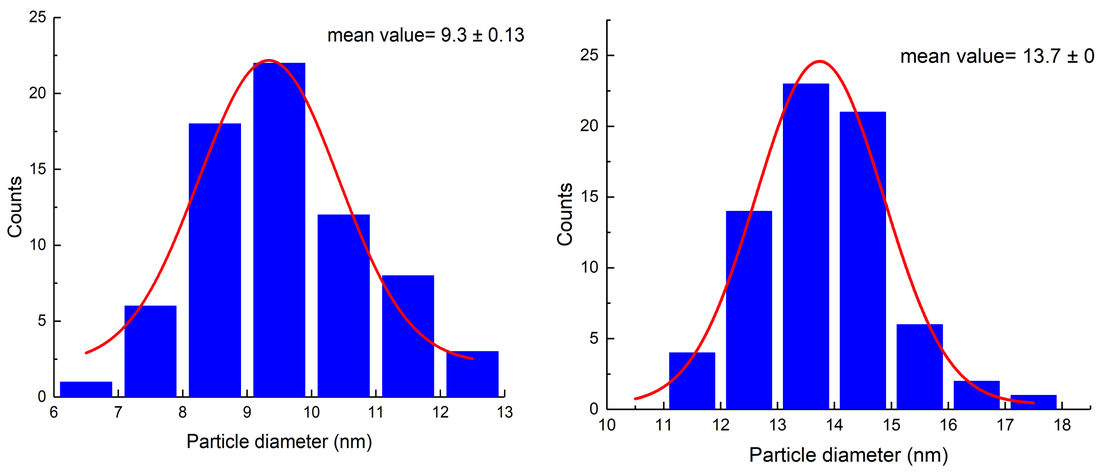
1. Disassembly of HumAfFt by reducing the $MgCl_2$ concentration.
2. Addition of 10 nm SPIONs in a 1:1 ratio.
3. Reassembly of HumAfFt in the presence of SPIONs by monitoring the concentration of $MgCl_2$.

- HumAfFt-SPIONs are magnetic!

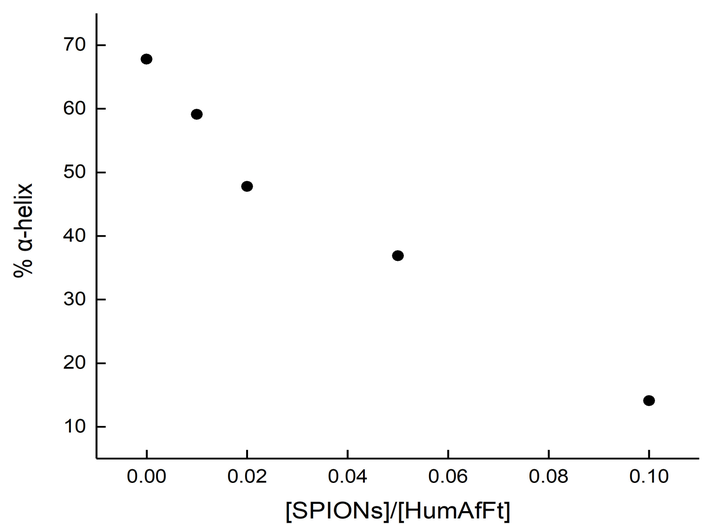
Upon the magnet application outside the vial, HumAfFt-SPIONs were rapidly recovered and accumulated near the magnet.

RESULTS AND CONCLUSIONS





- TEM images of SPIONs (a) and HumAfFt-SPIONs (b) with size distribution.



- The α-helix content (%) of HumAfFt as a function of [SPIONs]/[HumAfFt].

- Room temperature EPR signals for SPIONs and HumAfFt-SPIONs.

- ZFC and FC magnetization curves for SPIONs and HumAfFt-SPIONs.

The size of this new magnetic nanocarrier was estimated to be ≅ 14 nm and CD spectra revelead that SPIONs changed the HumAfFt conformation, with a reduction of α-helix content in the HumAfFt structure when the concentration of SPIONs increases. A very broad and strong single asymmetric microwave resonance signal was observed in EPR spectrum at a field of around 2600 G, linewidths of ≅ 300 G and g-value of 2.7 for the SPIONs. Both the resonance field and the linewidth increased due to the coating; resonance field of around 2800 G, linewidths of ≅ 548 G and g-values of 2.3 for HumAfFt-SPIONs. The total effective magnetic moment of the SPIONs decreased due to coating, which is due to a non-collinear spin structure originated from the pinning of the surface spins and coated ferritin at the interface of nanoparticles. The ZFC and FC curves confirmed that both the dry samples were fully superparamagnetic at 250 K. These results showed that the obtained HumAfFt-SPIONs is a promising magnetic nanocarrier.

REFERENCES

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[2]Affatigato, L.; Licciardi, M.; Bonamore, A.; Martorana, A.; Incocciati, A.; Boffi, A.; Militello, V. Ferritin-Coated SPIONs as New Cancer Cell Targeted Magnetic Nanocarrier. Molecules 2023, 28, 1163.