Polydopamine-functionalized superparamagnetic clusters as theranostic system

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Abstract

In recent years, the applications of nanotechnologies have made it possible to design smart nanosystems able to respond with physical-morphological modifications to the environmental characteristics typical of tumor tissues.[1] In this work, we propose and demonstrate the synthesis of bioinspired polydopamine-functionalized superparamagnetic clusters (MNC@PDO) to be applied as a magnetic field-guided theranostic system. This nanocomposite combines the capabilities of highly sensitive magnetic resonance imaging (MRI) and the delivery of cisplatin for cancer therapy. In this scenario, the first synthetic step is based on an oil-phase evaporation-induced self-assembly strategy, to fabricate the magnetic nanocrystal cluster (MNC). We demonstrated that the choice of the best size and volume of SPIONs, the adopted solvent and the surfactant concentration are very important parameters. With this approach, we can produce nanoclusters with a high density of magnetic cores, a size comprised between 90 and 100 nm, and a multilayer structure. Secondly, the surface of the MNCs was functionalized with polydopamine (PDO) for improving their stability;[2] moreover, different concentrations of dopamine were assayed to determine the best compromise between stability of the clusters and loading capacity. Finally, the cisplatin was grafted to the surface of stable MNC@PDO systems (MNC@PDO-cisplatin), studying its release efficiency from these nanoparticles. The MNC@PDO systems reveal to be promising models for the uptake and specific tissue delivery of chemotherapeutic drugs. Furthermore, the MNC@PDO nanosytem shows a pH-responsive behaviour of great significance in controlled drug delivery and targeting of specific sites. The antitumor potential of MNC@PDO-cisplatin was tested against HeLa (cisplatin-sensitive human cervical cancer cells) and MCF-7 (cisplatin-resistant human breast cancer cells). As expected, the drug carrier significantly improves the cellular uptake of platinum drugs. The cytotoxicity of the drug-loaded system is higher, or at least comparable, than cisplatin administration.

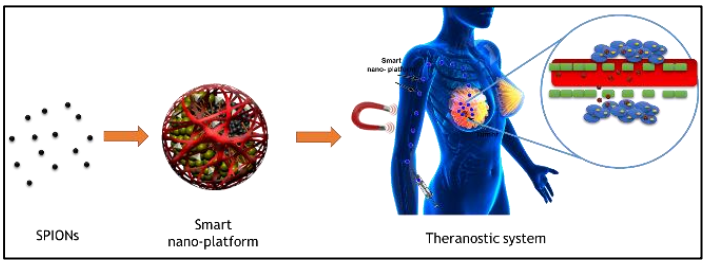

Fig. 1 Illustration of the synthesis procedures and magnetic field–directed theranostic applications of the theranostic MNC@PDO system.

References

1. Huang, H., Lovell, J. F. **Advanced functional materials** 2017, 27 (2).
2. Liu Y., Ai K.and Lu L. **Chemical Reviews** 2014, 114, 5057-5115.