Development of Stable Iron Oxide Nanoparticles for Dynamic Covalent Surface Functionalization

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ABSTRACT

Water dispersed surface-functionalized superparamagnetic iron oxide nanoparticles (SPIONs) have many applications in various fields and especially in biomedical research. The monodispersity and stability of these nanoparticles and the ability to functionalize their surfaces are critical factors for successful applications. Numerous approaches have been developed that aim at stable and monodispersed SPIONs in aqueous solution. Nevertheless, obtaining water-soluble SPIONs that are stable for prolonged periods (i.e. months) remains challenging. Here, a series of ligands was synthesized featuring nitrocatechol as SPIONs anchor and different polar groups for water solubility. We found that nanoparticles coated with zwitterionic ligands were stable for well over two months, which exceeded the stability of analogues containing negatively charged, positively charged or neutral ligands. A choline phosphate-based zwitterionic ligand was further functionalized with an aldehyde group that facilitated facile additional surface functionalization by means of hydrazone chemistry. These results establish SPIONs as a new platform for reversible covalent surface functionalization, opening up new opportunities in systems chemistry and biomedical applications.

Keywords: dynamic covalent chemistry, surface-functionalization; magnetic nanoparticles; hydrazones.

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