Journal of
Nanoscience and Nanotechnology
Vol. 12, 5132–5137, 2012

RESEARCH ARTICLE

Gold-Coated Iron Oxide Nanoparticles as a T_2 Contrast Agent in Magnetic Resonance Imaging

Tanveer Ahmad[1], Hongsub Bae[1], Ilsu Rhee[1,*], Yongmin Chang[2], Seong-Uk Jin[2], and Sungwook Hong[3]

[1] Department of Physics, Kyungpook National University, Daegu, 702-701, Korea
[2] Department of Molecular Medicine and DiagnosticRadiology, Kyungpook University Hospital, Daegu, 700-422, Korea
[3] Division of Science Education, Daegu University, Gyeongsan, 712-714, Korea

Gold-coated iron oxide (Fe_3O_4) nanoparticles were synthesized for use as a T_2 contrast agent in magnetic resonance imaging (MRI). The coated nanoparticles were spherical in shape with an average diameter of 20 nm. The gold shell was about 2 nm thick. The bonding status of the gold on the nanoparticle surfaces was checked using a Fourier transform infrared spectrometer (FTIR). The FTIR spectra confirmed the attachment of homocysteine, in the form of thiolates, to the Au shell of the Au-Fe_3O_4 nanoparticles. The relaxivity ratio, R_2/R_1, for the coated nanoparticles was 3-fold higher than that of a commercial contrast agent, Resovist, which showed the potential for their use as a T_2 contrast agent with high efficacy. In animal experiments, the presence of the nanoparticles in rat liver resulted in a 71% decrease in signal intensity in T_2-weighted MR images, indicating that our gold-coated iron oxide nanoparticles are suitable for use as a T_2 contrast agent in MRI.

Keywords: Gold-Coated Iron Oxide Nanoparticles, Contrast Agent of MRI, Relaxivity.

1. INTRODUCTION

Magnetic iron oxide nanoparticles are extremely useful due to their unique properties and potential application in areas such as magnetic guided drug delivery,[1] specific targeting and imaging of cancer cells,[2] hyperthermia treatment of solid tumors,[3] and contrast enhancement agents in magnetic resonance imaging (MRI).[4] MRI has been one of the most powerful medical diagnostic tools due to its non-invasive nature and multidimensional tomographic capabilities along with high spatial resolution. In MRI techniques, magnetic nanoparticles can be utilized as magnetic probes with signal-enhancing capabilities. However, a lack of surface tenability is one of the major obstacles to the use of these magnetic nanoparticles for biocompatible applications.

For the coating of magnetic nanoparticles with biocompatible layers, various techniques have been widely studied. Coating superparamagnetic iron oxides with an organic shell such as macro cyclic surfactants[5] and polymers,[6] or with an inorganic shell,[7] can enhance the stability, dispersibility, and functionality of the otherwise bare magnetic nanoparticles. The coating of magnetic nanoparticles with polymers[8] or a silica shell[9] has been extensively studied.

Gold and silver are ideal coating materials for biomedical applications due to their low reactivity, high chemical stability, and biocompatibility.[10] In particular, a magnetic core-gold shell structure provides a fascinating class of biomaterials, since the well-established surface chemistry and biological reactivity of gold can impart the magnetic nanoparticles with the desired chemical or biomedical properties without degradation of the magnetic properties.[11–13] In addition, the gold coating provides a platform for surface modification and further functionalization for medical applications. Magnetic nanoparticles become stable even in corrosive biological conditions after coating with gold and can be easily modified.[14]

However most of gold-coated magnetic nanoparticles are not quite water-soluble.[15] For biomedical application the magnetic nanoparticles have to be well dispersed in water without any aggregation. For *in vivo* applications, the aggregation of nanoparticles may lead to precipitation that could prove dangerous.[16] For the synthesis of water soluble gold coated nanoaparticles, the gold nanoparticle surfaces can be functionalized with thiolated organic molecules.[17,18] Gold-thiol chemistry can be used

*Author to whom correspondence should be addressed.

 1533-4880/2012/12/5132/006 doi:10.1166/jnn.2012.6368