Steinhoff, Uwe; Liebl, Maik; Wiekhorst, Frank; Haueisen, Jens; Trahms, Lutz:

Experimental progress in spatially resolved quantification of magnetic nanoparticles based on linear susceptibility measurements

DOI: 10.22032/dbt.40009

URN: urn:nbn:de:gbv:ilm1-2019210074

Zuerst erschienen in:	Biomedizinische Technik = Biomedical Engineering. - Berlin [u.a.] : de Gruyter. - 56 (2011), Suppl. 1, A, p. [6].
Erstveröffentlichung:	2011-09-30
ISSN (online):	1862-278X
ISSN (print):	0013-5585
DOI (Sammlung):	10.1515/BMT.2011.805
[*DOI:*	*10.1515/BMT.2011.230*]
[*Zuletzt gesehen:*	2019-08-16]

Biomed Tech 2011; 56 (Suppl. 1) © 2011 by Walter de Gruyter • Berlin • Boston. DOI 10.1515/BMT.2011.230

Experimental progress in spatially resolved quantification of magnetic nanoparticles based on linear susceptibility measurements

Steinhoff U. [1], Liebl M. [1,2], Wiekhorst F. [1], Haueisen J. [2], Trahms L. [1], [1]Physikalisch-Technische Bundesanstalt, Berlin, Germany, [2]Ilmenau University of Technology, Ilmenau, Germany
Email: uwe.steinhoff@ptb.de

Introduction

Magnetic nanoparticles (MNP) have a great potential for clinical application, e.g. as contrast agent in magnetic resonance tomography and magnetic particle imaging, as substance carrier in magnetic drug targeting and magnetofection, or as thermal actuator in magnetic hyperthermia. For all these applications, it is essential to have a noninvasive measurement method for the quantitative determination of MNP content in tissue and organs.

Methods

It is well known, that MNP can be quantified by measuring their linear magnetic AC-susceptibility (ACS) or by magnetorelaxometry (MRX). Here, we suggest estimating the spatially distributed MNP amount from such measurement data by using multiple sensors in combination with multiple excitation coils. We constructed different measurement setups using homogeneous and inhomogeneous magnetic excitation fields and performed ACS (20 Hz to 80 kHz) and MRX measurements with multiple SQUID sensors on spatially distributed MNP sources. The influence of the excitation fields on the sensors was suppressed by appropriate coil configuration (ACS and MRX) or by time-delayed measurement (MRX).

Results

Comparison of computational results for the numerical forward problem with real measurement values led to a quantitative estimation of MNP content using both linear ACS and MRX measurements. Multiple MNP accumulations with less than 50 µg Fe could be quantified over a distance of up to 100 mm. The separation of multiple sources was possible by combining several measurements with different excitation coils. The excitation field strength was below 1 mT and in some cases even below 1 µT.

Conclusion

We demonstrated experimentally the possibility to quantify spatially distributed MNP sources using ACS or MRX excitation techniques, multiple coils and multiple sensors. In contrast to magnetic particle imaging, these results were reached using small excitation fields below 1 mT. Further experiments with increased source complexity are needed to get robust estimates for the spatial resolution of the method.