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Nanotechnology - Test method for the magnetic resonance relaxivity of ferrite nanoparticles

纳米技术 铁氧体纳米颗粒磁共振弛豫效能测试方法

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part

1.Structure and Drafting Rules of Standardization Documents". Drafting. Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents. This document was proposed by the Chinese Academy of Sciences. This document is under the jurisdiction of the National Technical Committee on Standardization of Nanotechnology (SAC/TC279). This document was drafted by: Northwest University, West China Second University Hospital of Sichuan University, The First Affiliated Hospital of Xi'an Jiaotong University School of Medicine, and Xi'an Guo International Medical Center Co., Ltd., Southeast University, Zhuhai People's Hospital, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, and the Third Affiliated Hospital of Sun Yat-sen University Hospital, Xi'an Supermagnetic Nanobiotechnology Co., Ltd., Chengdu Supermagnetic Source Imaging Medical Technology Co., Ltd., Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences The institute, Beijing Chaoyang Hospital affiliated to Capital Medical University, Nanjing Drum Tower Hospital, Tongji University, West China Hospital of Sichuan University, and Nanjing University. The main drafters of this document are. Fan Haiming, Peng Mingli, Zhang Huan, Liu Xiaoli, Chen Baoying, Zhang Yu, Guo Yingkun, Yu Xiangrong, Wang Yining, and Jiao Ju. Liu Minrui, Yu Hongbin, Wang Xuan, Yao Huanyu, Lei Da, Yang

Ding, Ren Shuaijun, Xu Haiyan, Yang Qi, Mao Yu, Zhang Bingbo, Xia Chunchao, Gu Ning.

Ferrite nanomaterials are an important type of inorganic nanobiomaterial, with the chemical composition. MxFe3-xO4 (M = Fe, Mn, Cu,...). (Mg, Zn, etc.), in which metal ions M2 and Fe3 fill the tetrahedral (Td) and octahedral (Oh) vacancies formed by oxygen atoms, forming Nanocrystals with spinel or anti-spinel structures. Ferrite nanoparticles, with their unique magnetic properties and size, composition, and surface-dependent relaxation enhancement properties, are easily surface functionalized. Modified and possessing good biocompatibility, it is often used as a contrast agent in magnetic resonance imaging to enhance imaging signal intensity, particularly in malignant tumors, cardiovascular and cerebrovascular diseases. It has important applications in imaging examinations of vascular and neurological diseases. Relaxation efficiency is a characterizing property of contrast agents enhancing magnetic resonance signals. The key physical quantity of capability is typically quantitatively assessed by measuring the acceleration of the hydrogen proton relaxation rate per unit concentration of contrast agent. This parameter is related to... The composition, size, morphology, and surface properties of ferrite contrast agents are closely related; this multi-factor correlation makes accurate testing of relaxation efficiency difficult. This is an indispensable key step in the industrial-scale preparation and quality control of ferrite nanoparticles. However, a unified standard has not yet been established domestically or internationally. Standard testing methods. This document utilizes T1 mapping based on variable flip angle gradient echo sequences (or based on variable inversion time fast spin echo sequences). T1 mapping based on the sequence and T2 mapping based on the variable echo time fast spin echo sequence were calculated using magnetic resonance post-processing software. The relaxation time values are directly read from the pseudo-color image to calculate the longitudinal relaxation time T1 and transverse relaxation time of ferrite nanoparticles. The quantitative measurement of T2 was followed by linear regression of the reciprocal of the relaxation time against the concentration of ferrite nanoparticles, thus constructing a complete set of... A standardized testing method for the relaxation efficiency of ferrite nanoparticles. This method is simple, fast, accurate, and widely applicable. Nanotechnology Ferrite Nanoparticle Magnetic Resonance Relaxation performance testing method Warning

---Some reagents used in this document are corrosive and should be handled with care to avoid contact with skin and clothing. Relaxation efficiency test A clinical MRI scanner is required. MRI scanners operate under strong magnetic fields; therefore, please avoid bringing metal objects into the MRI scanning area. People with metallic foreign bodies (such as pacemakers, post-operative metal vascular clips, or metal implants) should avoid entering the MRI scanning room to prevent [the spread of the virus]. Danger has occurred. Magnetic resonance imaging (MRI) scanners must be operated by qualified technicians.

1 Scope

GB/T 47280-2026 is the Chinese national standard covering how strongly an iron oxide nanoparticle shortens the relaxation of the water around it - the relaxivity that determines its usefulness as an MRI contrast agent, and the measurement that lets two preparations be compared. First edition, in force since 1 October 2026, under the Chinese Academy of Sciences. It was issued on 31 March 2026 and takes effect on 1 October 2026, as a first edition. This page is published from the official record of the 2026 edition; the clause text of a standard this recent is not yet in circulation, and the figures, limits and tables it contains are those of the document itself, delivered in full with the English translation.

This document describes a method for testing the magnetic resonance relaxation efficiency of ferrite nanoparticles, including the preparation of samples with different concentrations, relaxation time, and... Testing of relaxation efficiency, etc. This document applies to the testing of the magnetic resonance relaxation efficiency of ferrite nanoparticles.

2 Normative references

The contents of the following documents, through normative references within the text, constitute essential provisions of this document. Dated citations are not included. For references to documents, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies. This document.

GB/T 626 Chemical Reagent Nitric Acid

GB/T 6682 Specifications and test methods for water used in analytical laboratories

GB/T 38812.3 Determination of the content of iron, silicon, manganese, phosphorus, vanadium, titanium, copper, aluminum, arsenic, magnesium, calcium, potassium, and sodium by direct reduction, including inductive coupling, etc. Ionic atomic emission spectrometry

3 Terms and Definitions

The following terms and definitions apply to this document.

3.1 nanoparticles Nano-objects with all three external dimensions at the nanoscale.

Note. If the difference between the longest and shortest axes of a nanomaterial is significant (greater than 3 times), nanoparticles are represented by nanofibers and nanosheets. [Source: ISO 80004-1.2023, 3.3.4]

3.2 Ferrite nanoparticles Nanoparticles with the chemical formula $M_xFe_{3-x}O_4$ (M = Fe, Mn, Zn, Cu, Mg, etc.) and possessing a spinel or anti-spinel structure.

3.3 The combined magnetization vector produced by the spin of the atomic nucleus in a magnetic field, when excited by a radio frequency signal, undergoes Larmor precession.

After the sign is removed, the time it takes for the component of the synthesized magnetization vector on its spin axis (Z-axis) to change back to its initial state (before the application of the radio frequency signal).

Note. The composite magnetization vector is restored to 1- based on its component along its spin axis (Z-axis). The longitudinal relaxation time value is determined at e().