EMRP Call 2011 - Health, SI Broader Scope & New Technologies

Selected Research Topic number: **SRT-h16**
Version: 1.0

Title: Diagnostics and therapy using magnetic nanoparticles

Abstract

This topic aims to make therapies based on magnetic nanoparticles (MNP) a reality by developing the first-ever metrological tools and regulations for their use in the healthcare. One proven method for early cancer diagnosis is to use MNPs combined with novel medical approaches to create multifunctional biomedical tools, allowing targeted delivery of toxic agents and specific treatment monitoring which help to improve survival rates and significantly reduce harmful side effects of chemo- and radiotherapy. The aim is to provide the metrological framework for use of MNPs by focusing on their controlled production, functionalisation and metrological evaluation of their physical properties, instrumental to their application in the health sector.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Health, New Technologies & Fundamental Metrology on pages 7 and 8.

Keywords

Magnetic nanoparticles (MNPs), early cancer diagnostic and treatment, magnetic drug targeting, controllable drug release, MRI, contrast agents, medical imaging, hyperthermia, magnetic thermoablation

Background to the Metrological Challenges

People living with cancer need treatments that are more effective locally, but less aggressive to their bodies. According to recent statistics, earlier detection of cancer could save between 5,000 and 10,000 lives a year in England alone. Currently conventional medical research suffers from late disease detection, nonspecific systematic drug distribution, inadequate local drug concentrations and inability to monitor therapeutic responses in real time. Nanotechnology has the potential to offer solutions to these obstacles [1], [2]. MNPs with properties of stability, specificity, drug encapsulation and imaging contrast are specifically designed to address limitations of conventional medicine and can be used clinically to diagnose disease, provide targeted cellular/tissue delivery of chemotherapeutics and to sustain drug effect locally.

MNPs are widely used for cell labelling, imaging and tracking. The composition, size, morphology and surface chemistry of particles can all be tailored. Currently iron oxide ferrites are the main component of MNPs, although such materials as Co and Mn ferrites, FePt and manganites can be also employed. The size of MNPs influences the specific area of their bio-applications.

Despite a large research effort and significant progress in the area, the corresponding metrology does not exist, due to the intrinsic difficulty and high cost of accurate and reproducible characterisation. Very few regulations on the use of both MNPs and related equipment for targeting, hyperthermia and drug release exist. Even for the established applications of MNPs in routine diagnostic procedures there is the urgent need for traceable measurement techniques that characterise MNPs. The consequences of this lack of metrology and regulations are late diagnostics and severe side effects, which currently have a significant impact on patient’s quality of life and often decrease survival prognoses.

EURAMET, EMRP-MSU
National Physical Laboratory
Hampton Road, Teddington,
Middlesex, TW11 0LW, UK

Phone: +44 20 8943 6666
emrpA169@npl.co.uk
www.euramet.org

EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

Scientific and Technological Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the JRP-Protocol.

The JRP shall focus on the traceable measurement to support new diagnostic technologies using magnetic nanoparticles.

The specific objectives are:

1. To develop stable functionalised magnetic nanoparticles (MNP) with well-defined physical and chemical properties including structural (TEM, SAXA, XPS, etc) and magnetic (SQUID, magnotorelaxometry etc) characterisation.
2. To develop spatially resolved magnetorelaxometry (MRX) based imaging of MNPs in biological systems including the construction of physical phantoms for comparison measurements and relevant mathematical models.
3. To develop delivery and measurement methods for volume/mass flow of MNPs suspended in liquids
4. To develop methods for thermal imaging and energy absorption/losses. Specifically:
   - Development of measurement methods and modelling techniques for the study of dielectric/magnetic characteristics and loss behaviour of MNPs suspended in liquids.
   - Construction of phantoms for magnetic heating using MNPs for key comparisons.
   - Imaging methods for temperature gradients in biological tissue caused by heating of MNPs.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes, and it is expected that multidisciplinary teams will be required. To enhance the impact of the research, the involvement of the appropriate user community such as medical practitioners and industry is strongly recommended.

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the Medical sector.

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] Q. A. Pankhurst, N. K. T. Thanh, S. K. Jones and J. Dobson, J. Phys. D: Appl. Phys. **2009**, 42, 224001. Progress in applications of magnetic nanoparticles for applications in biomedicine.

[2] C. C. Berry, J. Phys. D: Appl. Phys. **2009**, 42, 224003. Progress in the functionalisation of magnetic nanoparticles for applications in biomedicine.