

Title: Sustainable electrical machines and devices with reduced rare earth content

Abstract

Industry requires development of the existing European metrology capabilities for magnetic materials in order to meet the demanding operating conditions experienced during use in low carbon technologies. This JRP will establish real world measurement methods for magnetic materials that will accelerate the adoption of low carbon technologies and support rare earth material security strategies. The developed metrology needs to be a step change over traditional methods by making the measurements in air and by using pulsed fields.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on pages 8 and 9.

Keywords

Permanent magnetic motor, rare earths, NdFeB, ferrites, soft magnetic materials, operating conditions, sustainability, critical materials, low carbon technologies.

Background to the Metrological Challenges

The use of permanent magnets in the traction motors of electric vehicles (EVs) alone will grow considerably at a Compound Annual Growth Rate of 9.9% during the period 2015 to 2050. Additional demand is created by the use of magnets in other key low carbon technologies such as wind turbines, high speed rail motors and other high technology areas such as data storage and medical imaging. This has led the US DoE in its December 2011 Critical Materials Strategy to stress the urgent need to find alternative solutions that include new materials that reduce or replace the rare earth content of magnets as well as new device designs that eliminate or reduce the need for rare earth based materials. This is highlighted by its Rare Earth Alternatives in Critical Technologies for Energy (REACT) program through which the Advanced Research Projects Agency-Energy (ARPA-E) announced, in November 2011, \$31.6 million of funding for projects concerned with technologies reducing or eliminating the use of critical rare earth elements for EV motors and wind generators.

Currently, the measurements of room temperature properties of permanent magnets and soft magnetic materials, with standard geometries, are done in accordance with IEC, ASTM and JIS standards. Because the measurements of these written standards are highly skilled and require considerable resource to perform, they reside in a small number of research institutes worldwide. The European NMIs have the experience in the traditional measurement methods, theoretical knowledge of the magnetic properties and the skills to develop the computational tools to perform the step-change in the approaches necessary. Their existing capabilities means they are able to continuously compare the new techniques to show to industry that they are fully validated and can be used with the required confidence.

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 will establish real world measurement methods for magnetic materials that will accelerate the adoption of low carbon technologies and support rare earth material security strategies.

The specific objectives are:

1. To establish a traceable method with an uncertainty of 0.5 % for the full loop properties of standard permanent magnet geometries that meets acceptance by industry through measurement validation with the existing but restricted standards methods.
2. To enable the measurement of magnets with thicknesses of < 5 mm and the measurement of shaped magnets with a target measurement uncertainty of 1 %. These magnet thicknesses and shapes are necessary to reduce Eddy currents in industrial applications.
3. To develop physical models for determining the material properties by correcting for dynamical effects such as Eddy current and magnetic viscosity as well as self-demagnetisation.
4. To extend the traceable characterisation of soft magnetic materials for conditions such as: alternating fields, high frequencies and complex waveforms, applied biaxial stresses and temperature coefficients; and to develop physical models for predicting energy losses and static and dynamic hysteresis loops in soft magnetic materials under the working conditions relevant for applications
5. To demonstrate the capability of the new measurement methods, physical modelling and computational methods for the design and production of highly efficient electrical machines and systems

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

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. The available budget for integral Research Excellence Grants is 42 months of effort.

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 (e.g. letters of support) is encouraged.

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 magnetics industry sector.

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

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 and includes the best available contributions from across the metrology community. 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.