Title: Metrology for airborne manufactured and engineered nano-objects

Abstract

Airborne nanoparticles are becoming more prevalent due to the manufacture and increased use of engineered nano-objects, for example for improved coatings.

Airborne nanoparticles in ambient air can have potential adverse effects on the health of exposed workers and the general population. The evaluation of exposure and related health effects together with desired improvements in the manufacture, characterisation and quality control of engineered nano-objects require considerable technological developments. There is a strong need for robust, reliable, standardized and traceable online metrology for quantity and chemical composition, crystal structure, morphology, surface area, agglomeration, particle size and concentration of nano-objects.

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 9 and 25.

Keywords

Airborne nanoparticles and nano-objects, traceability, round robin test, risk assessment, validated chemical and physical methods, coagulation.

Background to the Metrological Challenges

The characterisation of nanoparticles is important for two reasons; reducing the potential health effects of nanoparticles and for quality control in industrial applications involving nanomaterials. For regulatory purposes the measurements of particulate matter are based on the determination of mass concentrations for PM10 and PM2.5 which are regulated in the European Directive 2008/50/EC.

Studies have indicated that airborne nano-objects in ambient air have potential adverse effects on the health of exposed workers and the general population. Therefore, there is need to focus on the toxicology and exposure assessment of nanoparticles, such as TiO_2, SiO_2 and carbon nanotubes which are manufactured in large quantities in industry. To perform reliable toxicology studies, it is necessary to determine the relevant characteristics of nanoparticles, such as morphology, surface area, agglomeration, crystal structure, chemical composition, particle size and concentration. On the other hand, manufacturing of nanomaterials and their use in industrial applications requires the traceable characterisation of the nanomaterials, particularly to enable the production of airborne nano-objects controlled by size, concentration, shape, surface area etc. One challenge is that characterisation of the size of airborne nanoparticles using SMPS (Scanning Mobility Particle Sizer) is derived from their electrical mobility under the assumption that the particles have spherical shape. For nanoparticles deviating significantly from spherical shape, classification according to electrical mobility can be misleading.

Industrial process control samples may contain several types of manufactured nano-objects, while workplace measurements will take place in potentially high concentrations of non-manufactured nano-objects, for example from combustion sources. Techniques are therefore required to enable discrimination between manufactured and non-manufactured nano-objects, as well as between different types of manufactured nano-objects.

Novel handheld nano-monitoring devices for measurements of concentration and size of airborne nano-objects at the workplace are coming onto the market; these new instruments are diffusion charging devices. The portability of these devices enables personal exposure monitoring, and furthermore due to their ease of use, real-time and continuous monitoring and lower price compared to the SMPS they are expected to become the preferred instrument for field use. These devices however require metrological characterisation and calibration to ensure traceable measurements.

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 development of a metrological infrastructure for traceable measurement of airborne engineered or manufactured nano-objects/particles, as necessary input for future directives and regulations aimed at reducing health risks.

The specific objectives are to

1. Select relevant reference particle/object types like carbon nano-tubes, silicon dioxide and titanium dioxide.
2. Develop suitable and traceable aerosol sources with defined characteristics with regard to, for instance, concentration and size distribution, for calibration purposes in laboratory and field. Technologies like Brownian coagulation can be considered for this.
3. Develop and evaluate methods for identification and chemical analysis of airborne particles. Specific objectives concern sampling, improved quantitative chemical analysis, reduced uncertainty and ease of application.
4. Develop and evaluate methods for reliable physical characterisation of morphological properties, taking into account specific characteristics of manufactured and engineered nano-objects like high aspect ratio.
5. Evaluate real-time equipment for onsite measurements and quantify their metrological performance.

The nano-objects under consideration need to be selected and prioritised according to declared stakeholder needs.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, and standardisation and regulatory bodies, is strongly recommended.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. The proposed JRP should clearly explain any relationship with existing results delivered from previously funded EMRP JRPs and demonstrate how it extends any relevant outputs from such JRPs, in particular related to

- T3 J1.1 Nanoparticles: Traceable characterization of nanoparticles
- ENV02 PartEmission: Emerging requirements for measuring pollutants from automotive exhaust emissions

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, for example via CEN 352
- transfer knowledge to the nanotechnology, environmental and health and safety sectors.

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.