EMPIR Call 2014 – Industry and Research Potential

Selected Research Topic number: **SRT-i27**
Version: 1.0

Title: Improved measurement technology for optically complex materials

Abstract

Many industrial products rely on optically complex materials whose radiation exchange has to be known exactly under the relevant conditions of their implementations, i.e. over 4π geometry and the entire solar- and thermal spectral range. In practice, the available information is often incomplete and/or does not sufficiently reflect the application conditions (e.g. limited detection angle, wavelength or temperature range). Different measuring set-ups are used in the laboratory and on the production site, often leading to different results. For relevant materials, improved measurement systems need to be developed and applied, comparisons on laboratory and on-site equipment performed and suitable reference materials for industry developed.

Keywords

Reflectance measurements, transmittance measurements, emissivity measurements, directional-hemispherical geometries, hemispherical-hemispherical geometries, solar absorbance, thermal emittance, radiation exchange, optically complex materials

Background to the Metrological Challenges

Radiation exchange of objects with their surroundings, or external sources, plays a key role in many industrial products based on solar-thermal energy conversion, photovoltaics and passive heating etc. Provided that materials used in such applications are lambertian (very diffusing) or mirror-like, planar and without significant texture, the currently available optical characterisation methods are considered to be appropriate, at least for laboratory measurements. However, optically complex materials are continually being introduced in diverse applications, leading to significant angular dependent effects such as light pipe trapping, spatial confinement / redistribution of light and similar. Optical measurements of such materials for radiation exchange purposes are often performed under simplified conditions and no information is available on the uncertainties; but realistic conditions often require measuring on curved surfaces, at high temperatures, under vacuum or special environmental conditions, thereby limiting the development, production control and application of these materials in many fields of industry (e.g. producers of special effect coatings, glazing, functional materials for sustainable energy and the building sector).

Many studies have considered uncertainties due to intrinsic errors of the measurement equipment, but little research has been devoted to problems caused by optically complex samples that influence the angular distribution of radiation. The recommended measurement procedures concern the size of the sample port and port-induced errors, but, the uncertainties obtained for optically complex samples are not specified and no advice is given for substitution- and comparison-type spheres. Laboratory and portable instruments have different integrating spheres and, in general, provide different spectral data for the same samples, even at the same measuring geometry.

CEN TC89 WG12 is currently trying to standardise test procedures performed on reflective insulation products to demonstrate their efficiency as insulation systems for buildings. Improvement of total hemispherical emittance measurements of reflective insulations is urgently needed for such products and for the development of new insulation systems based on high reflection of thermal radiation in the infrared wavelengths (vacuum insulation systems).

Producers of measuring equipment require reliable guidance for portable equipment for field measurements, especially if optically complex samples are considered, and solutions for such measurement techniques and uncertainties are required. Proper reference materials also need to be available, together with traceability to spectroscopic instruments at the production site. Corresponding measurement capabilities of NMIs must also be improved to follow emerging industrial needs.

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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 proposal.

The JRP shall focus on traceable measurement and characterisation of optically complex materials for use in industry working on products based on radiation exchange.

The specific objectives are

1. To develop tools and methods for the characterisation of optically complex materials using high level optical measuring techniques in solar and thermal spectral ranges, over 4π geometry.
2. To assure the traceability of radiation properties, as measured by different users. This should include the development and calibration of optical reference materials, measurement of their optical properties using highly accurate instruments and comparison of results with measurement techniques used in industry.
3. To develop and validate simplified measurement configurations for portable equipment.
4. To ensure that the outputs from the JRP are effectively disseminated to and exploited by industry working on products based on radiation exchange, such as through guidelines and standardisation or through facilitation of uptake of the technology developed by the project, if suitable, thereby supporting the development of new, innovative products and services and thereby enhance the competitiveness of EU industry.

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 – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this and EMRP JRP project IND52 (xDReflect) 'Multidimensional reflectometry for industry'.

EURAMET expects the average EU Contribution for the selected JRPs to be 1.5 M€, and has defined an upper limit of 1.8 M€ for any project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

Address the SRT objectives and deliver solutions to the documented needs,

- Drive innovation in industrial production and facilitate new or significantly improved products through exploiting top-level metrological technology,
- Improve the competitiveness of EU industry,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the solar-thermal energy sector.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects"

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include 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 EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.