Potential European Partnership on Metrology
Call 2021 – Green Deal and Normative

Selected Research Topic number: **SRT-v04**
Version: 1.1

Important information about these documents

This call is being held ahead of any agreement from the Commission that the relevant funding will be available. At present the relevant legislation is still under discussion in both Council and Parliament, and there is no certainty on the detailed arrangements for funding selected projects. The funding of any selected project, and the terms and conditions of participation in the projects, are dependent on completion of the legislative process and the subsequent contractual processes between the European Commission and EURAMET. Proposers submit to this call at their own risk.

Background

Last year, EURAMET submitted a draft proposal to the EC for a further research programme to be established under article 185 of the Treaty on the Functioning of the European Union (TFEU) to follow on from EMRP and EMPIR. This was published by the EC at https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe/candidates-digital-industry-and-space_en

The initiative would be called the European Partnership on Metrology and would aim to create, by 2030, a sustainable and effective system for metrology at European level that ensures Europe has a world-class metrology system that:

- Provides metrology solutions, fundamental metrological reference data and methods, offering fit-for-purpose solutions supporting and stimulating European innovation and responding to societal challenges.
- Supports and enables effective design and implementation of regulation and standards that underpin public policies that address societal challenges.

The Commission commissioned an impact assessment into this proposal and 11 others in similar priority areas, and, based on those findings, published their own proposal for the Partnership, their response to the impact assessment and a draft of the Decision on 23rd February 2021. See:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:89:FIN

https://ec.europa.eu/commission/presscorner/detail/en/ip_21_702

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0035&qid=1614677899327

That draft Decision is currently under discussion in the European Council and the European Parliament.

Under the assumption that the Council and Parliament pass the basic act which would form the legal basis for this research programme, and that the participating countries named in the Draft Decision submit the required commitment letters, EURAMET is publishing these potential Selected Research Topics and draft guidance notes. These documents are not approved by the Commission nor will they lead to a binding decision by EURAMET e.V. for any further negotiation or funding. All published guides and templates are subject to amendment by the EC and EURAMET e.V. as further information becomes known.

EURAMET MSU,
Phone: +44 20 8943 6666 Email: EMPIR.msu@euramet.org
msu.euramet.org

Title: Metrology for the rapid and accurate characterisation of Lithium-Ion batteries

Abstract

Lithium-Ion Batteries (LIBs) are a key enabling technology for e-mobility and for stationary storage. However, state-of-the-art characterisation techniques for LIB cells, modules and packs currently lack the accuracy and speed that is required to determine the parameters that are used to guarantee their safe, efficient and sustainable production, use and decommissioning. Therefore, this SRT focuses on the establishment of the metrological infrastructure required to underpin advances in battery management systems, and on the establishment of international standards, in compliance with the new European Batteries Directive.

Keywords

Lithium-ion battery, European Batteries Directive, battery safety, battery management system, battery sustainability, battery performance

Background to the Metrological Challenges

The European Commission has called for action to develop standards on the performance, safety and sustainability of batteries, in particular LIBs, in order to comply with the 2020 European Batteries Directive and to meet the EU's net-zero targets. LIBs are widely used in a variety of electric device applications, including electric vehicles. Therefore, car manufacturers need to guarantee vehicle performance and safety for long periods of time. However, the ability to accurately determine the state of charge (SOC), state of health (SOH) and state of safety (SOS) of LIBs is challenging using current methods.

Cells with nearly identical features need to be combined in order to guarantee the required high performance, and lifetime, of LIB modules. However, poor data quality has led to the suboptimal use of resources, and this has impaired the sustainability of LIB modules and packs. This situation needs to be improved through the use of accurate and rapid measurements of relevant LIB features, which can be reliably compared with a robust metrological uncertainty assessment. To achieve this, several techniques need to be evaluated, e.g. electrochemical impedance spectroscopy (EIS), noise spectroscopy, total internal resistance analysis and self-discharge detection. EMPIR JRP 17IND10 LiBForSecUse is focusing on cells and it should provide the basis for further work on the treatment of modules and packs as well as on fast and on-line techniques.

The SOH and SOS of LIBs needs to be accurately determined during use, for example in electric vehicles, in order to maximise first life and to ensure safe operation. Uncertainty in these parameters currently leads to a premature end of first life or to the unsafe operation of LIBs. Therefore, a set of measurement techniques needs to be developed to identify the SOH and SOS of LIBs along with appropriate metrological characterisation including an understanding of the influence of environment parameters.

The main disadvantage of methods, such as EIS, which are currently used for the accurate and rapid measurement of relevant LIB features is that the data produced are hard to interpret and they are not adequately linked to performance and safety-relevant processes in the LIB. To tackle this problem, the processes occurring inside a LIB require quantitative in-depth investigation using e.g. structural, dimensional and thermal techniques, as well as post-mortem analyses. The findings from these measurements will need to be linked to the methods that are suitable for use when the LIB is in-operation.

Safety, especially in the case of battery failure, remains a major concern in relation to the widespread use of LIBs. Therefore, to ensure the protection of vehicle occupants, battery management systems (BMS) need to be able to accurately and rapidly register when the SOS of a LIB deteriorates. An accurate and reliable SOS determination should enable the long first life of the LIB without compromising on safety. This will require the development of accurate and sensitive measurement methods to reliably detect unsafe deterioration, such as thermal runaway, with sufficient warning to allow the effective deployment of mitigation measures.

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 protocol.

The JRP shall focus on the traceable measurement and characterisation of Lithium-Ion batteries (LIBs).

The specific objectives are:

1. To develop traceable characterisation methods for in-line quality control in LIB manufacturing, which should ensure that the cells produced are optimally combined in modules/packs during group assembly. In addition, new and existing diagnostic methodologies, including electrochemical, dimensional and thermal measurements, should be evaluated.
2. To validate the first life-cycle operation of LIB packs, by developing traceable measurement techniques for the fast, in-use, determination of their state of charge (SOC), state of health (SOH) and state of safety (SOS). These techniques should be implemented in future battery management systems (BMS). This objective should include the identification and evaluation of the cell response to conditions mimicking real operation, and an evaluation of the detrimental environmental impact from temperature, pressure, heat fluxes, vibration, RF and high-frequency noise.
3. To evaluate correlations between the design, performance, lifetime and safety of LIBs based on the results from objectives 1 and 2 through complementary off-line metrologically traceable laboratory techniques.
4. To identify battery ageing factors, especially the impact of end-of-life safety related features, by employing traceable and validated methods for the early detection of faults, as well as for other robust safety-related measures throughout the LIB life-cycle. To validate the use of the measurement techniques developed in objective 2 by applying existing ageing mechanisms to generate cells with controlled SOH and SOS, supported by the complementary measurements in objective 3.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (accredited laboratories, instrument manufacturers), standards developing organisations (ISO, CEN/CENELEC, IEC TC21, etc.), the European Battery Alliance (EBA250) and LIB manufacturers and end users.

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, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMPIR JRP 17IND10 LiBforSecUse and how their proposal will build on that.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.2 M€, and has defined an upper limit of 2.7 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

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,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to Lithium-Ion battery manufacturers and sectors using these batteries.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of the potential European Partnership on Metrology 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.