EURAMET’s European Metrology Network for Advanced Manufacturing

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Abstract

Advanced manufacturing has been identified by the European Commission as one of the key enabling technologies (KET). These KETs are predicted to increase industrial innovation by addressing societal challenges and creating innovative and sustainable economies. Developments in the field of advanced manufacturing are progressing rapidly, particularly accelerated by digitalisation technologies, demanding appropriate evaluation methods, measuring devices, guidelines and standards for quality control of manufacturing processes and products in multiple industries. The metrology needs of these industry sectors are regularly surveyed on workshops by the European Metrology Network (EMN) and prioritised according to the advice of the EMN's Stakeholder Council, which is currently consisting of 13 industry representatives. These metrology needs are published in the Strategic Research Agenda (SRA) and are regularly revised to address the most recent metrology requirements in the field of advanced manufacturing. The SRA serves as a guide for decision-makers from industry and politics, and scientists who apply for funding of their research. This article introduces the purpose of the SRA and a new approach for a planned ongoing survey of stakeholder needs on the EMN website.

Advanced manufacturing, metrology, European Metrology Network (EMN), Strategic Research Agenda (SRA), stakeholder

1. Who we are

Advanced manufacturing requires new and enhanced metrology methods to assure the quality of manufacturing processes and the resulting products. The European Metrology Network (EMN) for Advanced Manufacturing drives the high-level coordination of the metrology community in this field with the aim of promoting the impact of metrology developments for advanced manufacturing.

The network is operated by national metrology institutes and designated institutes in close cooperation with stakeholders from academia, industry, and international initiatives with an interest in advanced manufacturing (Table 1).

Table 1 Overview of active EMN members

Members with active role in the EMN	No
Metrology institutes and designated institutes	18
Primary contacts	18
Cross-sectional experts	15
Advanced materials experts	17
Smart manufacturing systems experts	14
Manufactured components & products experts	15
Partner expert	1
Stakeholder council members	13
International associations/organisations	5

1.1. Our Vision

The EMN's Vision is to establish a self-sustainable interactive network of experts and an infrastructure to support metrology for advanced manufacturing in Europe. The EMN strives for being the primary contact point for metrology challenges in the advanced manufacturing industry.

1.2. Our Mission

The EMN has the mission of supporting competitiveness and innovation of the European advanced manufacturing industry by further developing a metrology infrastructure in cooperation with stakeholders, providing access to metrology research, services, and knowledge transfer. The realisation approach of these actions is described in detail in Przyklenk et al., 2021 [2].

1.3. Our Objectives

The EMN has identified the following main areas to support advanced manufacturing technologies (Figure 1) by

- continued stakeholder dialogue - supported by high-level experts of the EMN stakeholder council - targeting future metrology needs to be addressed in joint research projects,
- regular interaction with existing and upcoming European Partnerships and other international organisations to identify future needs for providing metrology-related input for research programmes,
- developing and providing specific metrology knowledge transfer to the European advanced manufacturing industry and stakeholders,
- representing European interests in standardisation and regulation committees that are relevant for advanced manufacturing, and
- coordinated approach to further develop and maintain a European metrology infrastructure of measurement capabilities and metrology services to support the competitiveness of the European advanced manufacturing industry.

Figure 1 Objectives of the EMN for Advanced Manufacturing.

2. Strategic Research Agenda

The purpose of the strategic research agenda (SRA) is to collate and highlight the key measurement challenges and opportunities for metrology in the field of advanced manufacturing. Thus, the SRA is intended to facilitate coordination and prioritisation of advanced manufacturing metrology research and development activity in Europe and acts as a reference document for the wider metrology and advanced manufacturing community. The SRA focusses on the cross-cutting topics listed in Table 1. Additionally, the 13 key industry sectors of the EMN are addressed [2, 3]. The SRA content is available in compressed form on the EMN website [3]. The next update is planned in mid-2024.

3. Metrology needs in Nano- and Microelectronics

The metrology challenges for Nano- & Microelectronics were discussed in an Open Consultation, organised by EURAMET and the EMN on 8th July 2022 with contributions from major European companies addressing their metrology needs. Additional input was provided from other sources, such as the Chips Joint Undertaking [4] and the International Roadmap for Devices and Systems [5]. In the following, one of the identified needs is assigned to a cross-cutting topic as an example, so that the needs are represented along the entire production chain:

(i) Intelligent product design: Full and fast characterization of functional 3D nanostructures (dimension, materials/ composition, dopants, strain, optical and electrical properties) for new device technologies (compound semiconductors, micro-LED, power electronics and vertical-cavity surface-emitting lasers)

(ii) Advanced materials: Larger components in lithography machines may cause drift issues, for drift compensation near ideal raw materials and accurate methods for material property qualification are needed.

(iii) Smart manufacturing systems: In-line capabilities of metrology methods are needed, e.g. to measure carrier mobility.

(iv) Quality control and testing: Metrology to support introduction of high NA EUV lithography in high volume manufacturing.

(v) Digitalisation and vertical metrology integration: Integrating metrology tools along the whole semiconductor manufacturing lines (Industry 5.0).

(vi) Legislation and standardisation: Easy to use, time-stable industrial calibration standards to cover the whole parameter ranges of instruments and measurands.

(vii) Health and safety, environment and sustainability: Developing improved characterisation methods for carbonaceous materials and composite/multi-component substances.

(viii) Knowledge-transfer and accessibility: Pooling good practice guides from NMIs on EMN website.

4. Outlook – Stakeholder contact through a long-term survey

Staying in contact with stakeholders is a tremendously important task to know the latest trends and to predict future metrology requirements in advanced manufacturing accordingly. This exchange is currently realised through regular workshops. Supplementing these by a long-term stakeholder survey is planned. The idea is to investigate metrology requirements in various areas by means of indicating catchy adjectives, such as *precise*, *easy*, *safe* or *sustainable*, to permanently rank stakeholder needs of a wide metrology and manufacturing community.

Table 2 shows the planned survey as a prefilled table. The results of the survey will be updated and displayed as a cumulative graphic on the future EMN website.

Table 2 Content of a planned long-term online stakeholder survey.

	Cross-Cutting Topics							
	Intelligent product design	Advanced materials	Smart manufacturing & assembly	Quality control & testing	Digitalisation & vertical integration of metrology	Legislation & standardisation	Health & safety, environment & sustainability	Knowledge-transfer & accessibility
Precise	●	▼	▲	▲	●	●	▼	--
Traceable	●	●	●	▲	●	●	▲	--
Fast	▲	--	▲	▲	▼	--	▼	●
Easy	●	●	▲	●	▲	--	▲	●
Cheap	●	●	●	●	▲	▼	▼	▲
Safe	▲	▲	▲	▼	●	▲	▲	▼
Sustainab.	▲	▲	▲	▼	--	▲	▲	--

▲ Very limiting ● Limiting ▼ Not limiting -- Not applicable

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