

European Metrology Network (EMN) for Advanced Manufacturing: Understanding the challenges and requirements for metrology for advanced materials

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Abstract

EURAMET's European Metrology Network (EMN) for Advanced Manufacturing supported by European National Metrology Institutes (NMI's) and Designated Institutes (DIs), along with our partners and stakeholder Council continues to advocate for the metrology community supporting the progress in advanced manufacturing. Over the past year the EMN has placed a particular focus on Advanced Materials, recognising that innovation in this area is progressing faster than the availability of robust, standardised measurement and evaluation methods. This gap affects confidence, scale-up, investment and global trade. To address this, the EMN organised two large stakeholder workshops on Metrology for Advanced Materials to better understand future needs. This paper summarises key findings, and highlights developments of the EMN for Advanced Manufacturing.

Metrology, Advanced Manufacturing, Advanced Materials, European Metrology Network, open consultation

1. European Metrology Network for Advanced Manufacturing

The EMN for Advanced Manufacturing coordinates European metrology efforts on advanced manufacturing and advanced materials. Building on the Strategic Research Agenda (SRA) [1], the EMN has focused this year on advanced materials, an area where stakeholders consistently cite the need for reliable, comparable and traceable metrics, and one of the eight Cross-cutting Topics of the EMN (Fig. 1). This article reviews the progress made in understanding the challenges faced by stakeholders and the gaps in European capabilities, which aim to be addressed through future research topics.

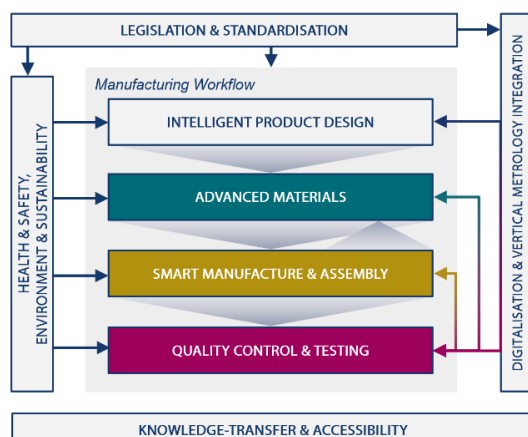


Figure 1. Cross-Cutting Topics of the EMN and their interrelationships. The three highlighted topics correspond to the EMN sections [1].

2. Annual General Meeting of the EMN

The annual general meeting of the EMN was held in hybrid mode and hosted at GUM, Kielce, Poland on 15th October 2025, including open and closed sessions.

2.1. Open stakeholder meeting

The open session, with over 40 participants, emphasised the need for integrated metrology approaches across emerging digital and manufacturing technologies, covering the following:

- Digitalisation in dimensional metrology
- Digital metrological twins in advanced manufacture
- Metrology for Industry 5.0
- European perspective on advanced manufacturing

2.2. Nanometrology for emerging national metrology institutes

An associated workshop addressed nanometrology capacity-building for emerging NMIs, covering:

- Introduction to nanometrology
- Metrology needs of stakeholders
- Towards traceable surface texture measurements using optical microscopes – EURAMET project 1242 and EMPIR TracOptic
- Nanoscopic technologies for nanometrology
- Perspectives from multiple European NMIs
- Traceability challenges in emerging NMIs

The outcome of the event was improved cooperation and support of European NMIs on the topic of Nanometrology.

3. Stakeholder consultation: Metrology for Advanced Materials

The EMN held two large stakeholder workshops in 2025 [2] with more than 300 participants to identify needs and priorities to support the Advanced Materials sector. The consultations covered Critical Materials, and Advanced Materials for Clean Energy, for Future Electronics, and for a Digital World.



Figure 2. One of the large stakeholder workshops organised by the EMN in 2025 (follow the QR code for further information)

The events included keynote contributions from the European Commission, IAM4EU, EURAMET, the EMN as well as from EU industry and leading academics to set the scene by highlighting the importance of advanced materials in the European commission strategy and how metrology is a key enabler for the advanced materials.

Open discussion sessions highlighted the need for reliable, comparable and traceable metrics for novel advanced materials and for accelerating the metrology standardisation process. The event reinforced that metrology is essential for confidence in novel advanced materials—from research to industrialisation—and that Europe needs faster development of standardised, traceable measurement methods.

3.1. Advanced Materials for Clean Energy

Focusing on photovoltaics, batteries and hydrogen technologies, the session highlighted:

- The need for reliable and comparable metrics
- Importance of operando and dynamic measurements
- Need for reproducibility and harmonised testing
- Need for benchmarks and traceability

3.2. Advanced Materials for Future Electronics

Focusing on complexity and scaling of semiconductor manufacturing, the session highlighted:

- Integration of multiple measurement techniques
- Introduction of new and complex materials
- Contamination analysis in semicond. manufacturing
- Scaling limits, especially for 2D and ultrathin layers
- Need to anticipate metrology requirements early to avoid industrialisation delays

3.3. Advanced Materials for a Digital World

Focusing on the requirements for Integrated Computational Materials Engineering (ICME) and Material Digitalization, the session highlighted:

- Data management based on FAIR principles
- Standardised uncertainty handling
- Material benchmarks for model validation
- AI and Machine Learning to fill data gaps
- Metrology to feed ICME and digital-twin dataflows

3.4. Critical Materials

Focused on emerging measurement and standardisation needs for Critical Materials, the event covered applications areas ranging from materials and composites to semiconductor and hydrogen technologies and explored how metrology supports innovation, circularity and resilience. The session highlighted:

- Substitution and recycling strategies
- Need for harmonised standards and digital traceability
- Challenges in reuse and end-of-life recovery

Breakout discussion sessions helped to identify and prioritise:

- Emerging measurement challenges (e.g. impurities, in-line metrology, data traceability)
- Areas for joint research (e.g. harmonised standards, lifecycle analysis, recycling protocols)
- Standardisation needs (e.g. reference materials, digital passports, design-for-recycling)

3.5. Outlook and perspective

Participants emphasised the need for early alignment of metrology with R&D roadmaps, ensuring measurement infrastructure keeps pace with materials innovation.

4. EU projects on metrology for advanced manufacturing

Running and recently completed research projects related to metrology for Advanced Manufacturing and Advanced Materials, funded by the European Partnership for Metrology can be found here [4], including:

- Traceability for industrial 3D digitalisation by advanced scanning systems – ScanCloudT
- Traceable machine vision systems for digital industrial application – DI-Vision
- Application of Digital Metrological Twins for emerging measurement technology in advanced manufacturing – ADAM
- Memristive devices as quantum standard for nanometrology – MEMQuD
- Standardised measurements of surface functionalities on nanoparticles – SMURFnano [3]

5. Conclusions

This article aimed to review the recent activities of the EMN for Advanced Manufacturing, in particular on the topic of Metrology for Advanced Materials.

Ongoing European Partnership on Metrology projects are already addressing key advanced-materials challenges, particularly the need for reliable, comparable and traceable metrics and accelerated standardisation.

Gaps identified in the SRA for Metrology for Advanced Manufacturing are being reassessed following the open consultation, and these insights will inform future updates.

References

- [1]<https://www.euramet.org/european-metrology-networks/advanced-manufacturing/strategy/strategic-research-agenda>
- [2]<https://www.euramet.org/european-metrology-networks/advanced-manufacturing/events>
- [3]<https://www.euramet.org/european-metrology-networks/advanced-manufacturing/research/projects/details/project/standardised-measurements-of-surface-functionalities-on-nanoparticles>.
- [4]<https://www.euramet.org/european-metrology-networks/advanced-manufacturing/research/projects>