European Metrology Programme for Innovation and Research

Industrial innovation

An overview of the funded projects from the Targeted Programme Industry.

The aim of these projects is to use cutting-edge measurement science to drive innovation in industry and facilitate new products.

The projects focus on new applications at the crossroads between different technologies to improve efficiency and effectiveness in high-tech industries and key industrial sectors, in order to ensure European industry remains globally competitive.

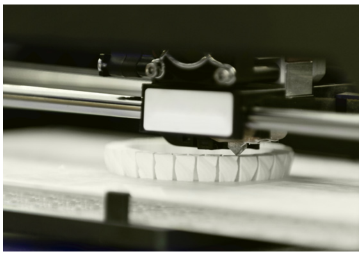
3D material measurements for innovative technologies

Advanced 3D chemical measurements for high-value manufacturing

Consumer demand for faster, smarter and cheaper technologies is driving innovation in high value-added manufacturing.

To satisfy these demands, industry is increasingly developing solutions based on 3D architectures, 3D printing and a rapidly expanding library of complex innovative materials. These techniques can create severe measurement difficulties such as the characterisation of the interface between the organic and inorganic materials used in the semiconductor industry. There is therefore an urgent need for beyond state-of-the-art measurement capabilities to allow exploitation of innovative complex materials.

This project will develop advanced measurement techniques for 3D-resolved chemical composition and interfacial material properties providing industry with trusted measurement capability and standardisation techniques. This will support the development of new, innovative products, enhancing the competitiveness of European industry.



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Project 14IND01

Advanced 3D chemical metrology for innovative technologies

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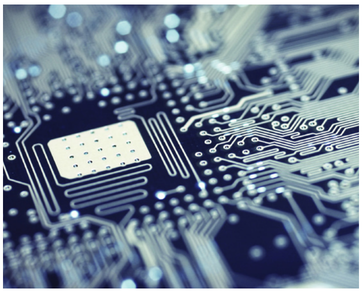
Supporting high-frequency technologies

Microwave measurements for high-frequency microchips

High-frequency microchips (or integrated circuits) are in widespread use and are a key enabling technology in systems that employ micro- and nano-electronics such as mobile communications and radar sensors in driverless cars. Increasing demands for higher data rates, and the development of high-resolution radar imaging, are continually pushing up the operating frequency of these systems.

Accurate and traceable measurements of such high-frequency integrated circuits are essential for system developments, providing confidence and lowering costs in industry. However, the uncertainties associated with currently available measurement procedures become more pronounced at high frequencies.

This project will enable the traceable measurement and characterisation of integrated circuits and components from radio-frequency to sub-mm frequencies with known measurement uncertainties. This will allow industry to develop components and devices in high-speed and microwave applications, such as wireless communications, automotive radar and medical sensing.



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Project 14IND02

Microwave measurements for planar circuits and components

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Smaller is stronger

Supporting length-scale engineering for lighter, stronger materials

According to conventional understanding regarding the strength of materials, a small and a large beam of the same material will fail under the same stress. However, in reality the small beam is stronger and this 'size effect' can change the strength of a material by up to an order of magnitude.

Industry has found that this size effect mechanism can be exploited through the addition of different atom sizes, particles and grain boundaries. Current state-of-the-art understanding of the interaction between these size effects is limited, and industry has had to make do with empirical relationships relating to individual length-scales. A validated, joined-up understanding of the mechanisms behind 'smaller being stronger' is needed to realise the material and component performance benefits that length-scale engineering offers.

This project will produce design rules and new measurement techniques which will enable industry to exploit length-scale engineered materials and create components that are lighter, stronger, and fatigue and wear resistant.

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Project 14IND03

Metrology for length-scale engineering of materials

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Enhancing efficiency through temperature measurement

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Improving temperature measurement capability in high-value manufacturing

The efficiency of high-value manufacturing processes is heavily reliant on accurate, traceable temperature measurement, with some processes requiring reliable control at temperatures up to 2000 °C.

Current state-of-the-art tools used by industry to measure high temperatures (above 1300 °C) suffer from drift and large measurement uncertainties. Even at lower temperatures (below 500 °C), used more widely in industrial processes, manufacturers often experience difficulty complying with the low uncertainties needed to satisfy standards due to the limitations of surface temperature measurement techniques. Improved measurement capability could lead to reduced product rejection and increased energy efficiency, reducing costs for manufacturers.

This project will significantly enhance the efficiency of high-value manufacturing processes by improving temperature measurement capability with new sensors and calibration techniques, and introducing traceability directly into processes.

Project 14IND04

Enhancing process efficiency through improved temperature measurement

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Secure quantum communications

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Optical metrology for quantum-enhanced telecommunications

With increasing amounts of data being sent and stored across networks, there is a pressing need to ensure data security. Quantum Key Distribution (QKD) provides two parties with a perfectly secure random key which can be used to encrypt and decrypt messages, offering a level of security beyond that possible with current systems.

QKD technology could be used to support the competitiveness of European industry and provide improved data security in banking, commerce, government, and the transmission of personal data, such as medical records. However, to achieve this, measurement infrastructure and standards for quantum optical technologies, such as QKD, are needed.

This project aims to accelerate the development and commercial success of QKD technologies, through the development of metrological capacity in quantum optical technologies. The project will provide efficient, cost-effective measurement techniques for the development of counter-measures to hacking attacks on existing QKD systems, as well as the foundational metrology needed for next-generation entanglement-based QKD systems.

Project 14IND05

Optical metrology for quantum enhanced secure telecommunication

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Improving efficiency and safety with pressure measurement

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New industrial standards in the intermediate pressure range

Accurate control of intermediate pressures in industrial environments can prevent the spread of contaminants and improve efficiency in many industrial processes, such as those used in power plants, petrochemical and pharmaceutical production, and the storage of nuclear and toxic wastes.

Traceable intermediate-range pressure measurements must be provided in these industries in order to satisfy international requirements regarding safety, precision, sterility and performance. Conventional calibration procedures are however extremely dependent on weather conditions and often target uncertainty levels cannot be achieved. High-accuracy primary standards and alternative calibration techniques, whose accuracy is independent of ambient conditions, need to be developed to meet the requirements of industry.

This project will develop new pressure standards and calibration methods for absolute, positive and negative gauge pressures in the intermediate range. The results will increase the efficiency and safety of industrial processes, provide a basis for new technologies and reduce the risk of environmental contamination.

Project 14IND06

Industrial standards in the intermediate pressure-to-vacuum range

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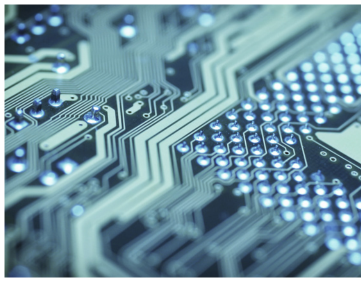
Enhancing performance with 3D microchips

Measurement techniques for manufacturing 3D integrated circuits

Performance requirements in the electronics industry can no longer be met by downsizing conventional semiconductor devices. More compact 3D microchips (also known as 3D integrated circuits) are being developed to meet requirements, offering reduced power consumption and increased speed over their 2D counterparts.

3D integration technology uses a type of electrical connection, known as a through-silicon vias (TSVs), to vertically stack chips and produce 3D integrated circuits with an optimum balance between cost, functionality, performance and power consumption. While this technology is already used in applications such as imager sensors and memory, its extension into new areas will require a greater density of smaller TSVs with higher aspect ratios.

This project will develop traceable measurement capabilities for detecting structural and chemical defects in high aspect ratio TSVs, and new methods to accurately characterise thermal and electrical properties at the nanoscale. This metrological infrastructure will allow Europe to play a more important role in the supply chain for future information systems built using highly dense electronics, and will create an enduring competitive advantage for Europe.



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Project 14IND07

Metrology for manufacturing 3D stacked integrated circuits

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Ultra-high voltage grids

Extending test methods for the electrical power industry

In order to minimise energy losses, electricity is transmitted through electricity grids at high voltage and low current. Efficiency requirements are driving the development of new products which can operate at higher grid voltages and with lower losses. Equipment for high voltage grids needs to be verified to check it can withstand operating conditions including high voltage and high current surges.

System voltages are reaching levels higher than those covered by existing calibration standards. Traceable test methods need to be extended into the ultra-high voltage range to ensure the quality and reliability of products.

This project will develop the measurement capability needed to prove the quality of equipment for high-voltage grids, and help to maintain the competitiveness of the European high-voltage electrical power industry.

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Project 14IND08

Metrology for the electrical power industry

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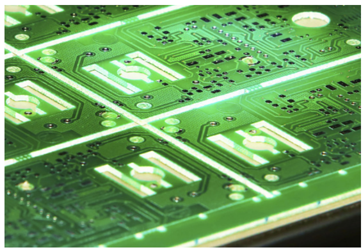
Enabling highly-parallel manufacturing

Measuring large-scale, fine-feature printed electronics

Highly-parallel manufacturing methods promise to cut costs by producing devices on large surfaces (on the square metre scale) with high feature resolutions (down to the micrometre scale) at high speed. Large-area printed electronics created using these methods have the potential to provide low-cost, smart devices for use in a variety of applications, such as photovoltaics for energy generation, sensors for instant, disposable medical tests and anti-counterfeit devices.

During manufacture, products may be travelling along the production line at speeds of several metres per second. This combined with the large surface size and small 3D features provide a measurement challenge that cannot be met by current inspection techniques in industry.

This project will enable significant improvements in highly-parallel manufacturing processes, such as roll-to-roll printed electronics, by enabling industry to make traceable measurements of surface features on large-area substrates. This will enable innovation and improve efficiency in the development of technologies to support Europe's high standard of living.



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Project 14IND09

Metrology for highly-parallel manufacturing

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Next generation communications

Developing metrology for 5G communications

Mobile communications are an essential part of daily life and mobile internet traffic demand is growing rapidly. To meet this demand, 5G mobile networks will be deployed from 2020 to provide a data transfer rate more than 1000 times greater than that of 4G systems.

Ahead of the roll-out of 5G networks, infrastructure and standards need to be developed. More work is needed to improve measurements of signal-to-interference-plus-noise ratio and multiple-input and multiple-output antenna systems (which use multiple transmitting and receiving antennas to improve network performance), and increase energy efficiency.

This project will develop the traceable metrology and standardisation to improve measurement uncertainties underpinning all aspects of 5G communications, including signals, devices, systems and test environments for emerging 5G technologies. This will give European industry a competitive advantage over global communications manufacturers in the development of solutions to 5G metrological problems.

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Project 14IND10
Metrology for 5G communications
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Improving efficiency with humidity monitoring

Humidity measurements at high temperatures and transient conditions

Air humidity directly affects the quality of pharmaceutical and food products during both production and storage processes. Recognising the importance of humidity monitoring to production efficiency, the food and pharmaceutical industries dedicate significant resources to the challenge of improving humidity measurements.

Many laboratories across Europe calibrate instruments for measuring humidity, but no appropriate methods and techniques are available for performing calibrations at temperatures above 100 °C or under transient conditions. These dynamic humidity measurements form an integral part of environmental monitoring during the manufacture of many industrial products but no proper methods exist to estimate their uncertainty.

This project will significantly improve the speed and accuracy of industrial humidity measurements at temperatures up to 180 °C and under transient conditions. The improved measurement and calibration techniques developed will help increase manufacturing efficiency in European industry and could potentially achieve annual savings of millions of euros across European industries.

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Project 14IND11
Metrology for humidity at high temperatures and transient conditions
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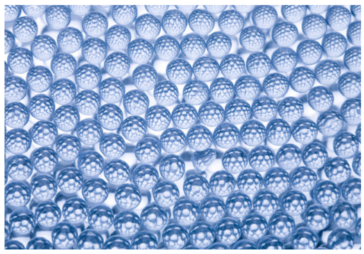
Supporting innovation with nanoparticles

Measuring nanoparticle concentration and chemistry

Nanoparticles, due to their unique and tuneable properties, are ideal for a wide variety of potential applications and are increasingly being used in commercial products, from conductive inks for printed electronics to drug delivery agents for the pharmaceutical industry.

Industries developing innovative products containing nanoparticles need to accurately control a number of their properties. Two properties which significantly affect performance are nanoparticle number concentration and surface chemistry. These properties enable compliance with EU regulation regarding the definition of a nanomaterial, and underpin claims of reliability, performance and lifetime for nanoparticle products. However, industry is currently lacking certified reference materials, primary standards and methods of measurement for these two properties.

This project will provide industry with techniques and methods for the measurement of nanoparticle number concentration and surface chemistry. This will support trade in high performance nanoparticles for advanced technologies and the competitiveness of European nanotechnology industries will be strengthened.



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Project 14IND12
Metrology for innovative nanoparticles
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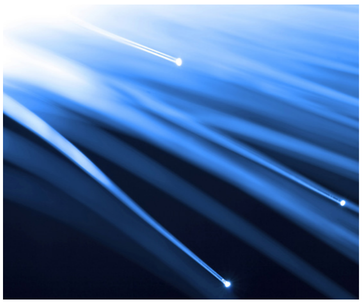
Next generation optical fibres

Improved metrology for the photonics industry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Optical fibres and other photonic components are being increasingly implemented in many rapidly-growing and demanding areas, such as aviation electronics, telecommunications and the automotive industry.

Modern photonic systems use novel components with dimensional and optical properties that cannot be reliably measured using conventional techniques. Dedicated measuring instruments are commercially available for some of the required characteristics, but they are often not calibrated and provide insufficient accuracy. New measurement technologies and improved metrology are needed to meet the demands of the photonics industry.

This project will develop characterisation and calibration techniques for the latest generation of photonic components and devices in both optical fibres and waveguides, which will underpin their development and manufacture. This will strengthen the competitiveness of the European photonics industry, enabling innovation and providing faster, cheaper data connections.

Project 14IND13
Metrology for the photonics industry - optical fibres, waveguides and applications
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Testing wind turbines

Traceable torque measurements for improved turbine testing


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The use of onshore and offshore wind farms is predicted to increase in many European countries, including Germany, Denmark and the UK, in order to meet targets for renewable energy generation. Reliability of wind energy supply depends on the reliability of the turbines themselves, and this growing market has already led to the construction of several test facilities to support the development of robust wind turbine generators (WTG).

Nacelle test benches assess the reliability of a WTG over its service life by simulating field conditions. These test benches work with torques in the meganewton metre range, however, no standards currently exist for torque measurements in this range.

This project aims to provide traceability for torque measurements in the meganewton metre range for nacelle test benches. This will improve test conditions for manufacturers, allowing a product's quality to be reliably verified and providing support for the wind energy industry.

Project 14IND14
Torque measurement in the MN•m range
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Europe's National Measurement Institutes working together

The majority of European countries have a National Measurement Institute (NMI) that ensures national measurement standards are consistent and comparable to international standards. They also investigate new and improved ways to measure, in response to the changing demands of the world. It makes sense for these NMIs to collaborate with one another, and the European Association of National Metrology Institutes (EURAMET) is the body that coordinates collaborative activities in Europe.

The European Metrology Programme for Innovation and Research (EMPIR) follows on from the successful European Metrology Research Programme (EMRP), both implemented by EURAMET. The programmes are jointly funded by the participating countries and the European Union and have a joint budget of over 1000 M€ for calls between 2009 and 2020. The programmes facilitate the formation of joint research projects between different NMIs and other organisations, including businesses, industry and universities. This accelerates innovation in areas where shared resources and decision-making processes are desirable because of economic factors and the distribution of expertise across countries or industrial sectors.

EURAMET wants to involve European industry and universities at all stages of the programme, from proposing Potential Research Topics to hosting researchers funded by grants to accelerate the adoption of the outputs of the projects.

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