EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope

Selected Research Topic number: **SRT-i02**
Version: 1.0

Title: Chemical metrology tools for manufacture of advanced biomaterials in the medical device industry

Abstract

The medical device industry is racing to include advanced biomaterials in their next generation of medical devices. Novel materials that employ surface modification, thin films and controlled drug release have the potential to improve patient outcomes and to reduce medical costs. Large scale manufacture of these materials will require advances in chemical metrology to facilitate both reliable on-line monitoring and detailed off-line characterisation, which are essential for quality management. Reproducible quantitative tools that are sensitive to surface chemical detail, defects, topography, contaminants, and the 3-D chemical distribution are needed to produce reliable devices that will ensure patient safety and will meet regulatory requirements.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on pages 13, 40 and 41.

Keywords

Medical devices, medical implants, surface analysis, anti-microbial surfaces, drug elution, on-line measurement, surface treatment.

Background to the Metrological Challenges

The global market for medical devices is estimated to be greater than €200 billion and European industry has about a 35 % market share. The industry has grown at a rate of 9 % over the past decade and the aging of the population is increasing the need for medical devices. World-wide, there are over 1 billion medical devices implanted annually in patients. Most devices are temporary but, over 18 million devices are implanted permanently each year. About 20 % of all adults in developed countries have an implanted medical device. These devices improve the quality of life for millions of patients and extend life for hundreds of thousands of people. However, failure rates are undesirably high across the board. Reducing the failure rate and enhancing the integration of implanted devices within the body is needed. To address these problems, promising advanced surface treatments and coatings (e.g. surface grafting of bio-molecules, non-fouling coatings, anti-microbial surface treatments and controlled release of bioactive agents) are being developed for use in the next generation of medical devices. Analytical tools like 3-D ToF-SIMS and 3-D XPS need to be developed for the characterisation of these coatings. However, these high vacuum techniques are not suitable for on-line analysis. Current on-line analysis techniques do not provide the level of surface specificity, chemical detail and spatial resolution needed for these new materials. Different techniques like ambient mass spectrometry, scanning probe microscope spectroscopy, surface enhanced vibrational spectroscopies and spectroscopic ellipsometry need to be developed for on-line analysis in a manufacturing environment to assure reliable production processes and to identify and fix manufacturing problems. Developments are also needed because these techniques vary in their spatial resolution, surface sensitivity or chemical specificity. Therefore, multivariate statistical models will likely be required to correlate these ambient measurements with key performance parameters.

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Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on the traceable measurement and characterisation of chemical metrology tools for use in the manufacture of advanced biomaterials in the medical device industry. Reproducible manufacture and quality management of advanced medical device materials should be improved and the underpinning metrology should be developed in order to satisfy existing and emerging regulatory requirements.

The specific objectives are

1. To develop repeatable and reliable ambient methods that are suitable for the on-line monitoring of advanced medical device materials, enabling the identification of relevant classes of chemical species with misidentification in <1 % of cases and concentration measurements to within 20 % precision.
2. To develop methods for improving the spatial resolution (to below 1 μm laterally and to below 10 nm in depth), repeatability and interpretability of existing quantitative 3D chemical analysis tools. The methods developed should support quality management objectives such as the identification of defects and failure mechanisms. Specific attention should be given to the constraints imposed upon the analysis by both the range of materials (metals, polymers, fabrics) and the topography of the medical devices.
3. To develop novel informatics and multivariate statistical approaches for multi-technique analysis (on-line ambient measurement and high-resolution 3-D methods) to relevant performance characteristics of advanced biomaterials.
4. To develop methods (e.g. scanning probe microscopy) for the analysis of the dimensional characteristics of the coatings, which are relevant for quality, such as defect distribution and density, topography and surface roughness.

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.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the medical device manufacturing sector.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.