Publishable Summary for 17SIP03 ESCoShell
An ISO Technical Report on the use of Electron Spectroscopy for Measurement of Core-Shell Nanoparticle Shell Thicknesses

Overview

The aim of this project is to produce an ISO Technical Report on measurement of coating thicknesses (often referred to as the 'shell' thickness) on nanoparticles using electron spectroscopies such as X-ray spectroscopy (XPS) and Auger spectroscopy (AES). This will help maximise the outputs of the EMRP BioSurf project which established the underlying metrology of key aspects of nanoparticle coating characterisation. The project will develop the ISO Technical Report and bring this to publication through ISO/TC 201 by 2021. This will provide the user community with much needed validated methodology for measurement of nanoparticle coating thickness, increasingly needed in the fields of medical diagnostics, catalysis and optoelectronics.

Need

The Primary Supporter of this project, ISO/TC 201/SG1, "Nano-materials characterisation", represented by Don Baer (Pacific Northwest National Laboratory, USA) has requested that the underlying metrology developed in HLT04 BioSurf on the measurement of nanoparticle coatings be conveyed into a New Work Item to meet industry needs for progress towards standardisation of core-shell nanoparticle characterisation.

Coated nanoparticles are increasingly used in a wide variety of industries including medical diagnostics, catalysis and optoelectronics such as photovoltaic devices. In any application, knowledge of the thickness and surface chemistry of a nanoparticle coating is extremely important in understanding its behaviour and interactions with their environment. The capability to perform such measurements can be provided by electron spectroscopy. The ability to reproducibly and accurately characterise such nanoparticles is thus vital for the eventual development of nanoparticle systems for use in commercial applications. The ISO Technical Report produced by this project will aid in the quick dissemination of protocols for sample preparation and analysis developed under HLT04 BioSurf, allowing for reproducible analysis of nanoparticle systems between instruments and laboratories.

Objectives

The objective of the project is to maximise the impact of BioSurf specifically;

1. To publish an ISO Technical Report in ISO TC201 on methods for determination of nanoparticle coating thicknesses using electron spectroscopies
2. To ensure the relevant user communities are aware of the ISO Technical Report and how it can improve the validity of their measurements and the development of their products.

Results

1. *To publish an ISO Technical Report in ISO TC201 on methods for determination of nanoparticle coating thicknesses using electron spectroscopies*

The aim here is the publication of an ISO Technical Report under ISO TC201 (Surface chemical analysis) on the use of electron spectroscopies for measurement of nanoparticle coating thicknesses. It will cover a variety of methods and concerns around the measurement of nanoparticle coatings using electron spectroscopy, and is intended to ensure that nanoparticle characterisation can be performed accurately and consistently between different analysts and instruments, providing users with confidence in the validity of their measurements. The effects of a range of variant nanoparticle structures, polydispersity, and composition on the interpretation of electron spectroscopy data will be described. An initial draft will be written with input from expert stakeholders, followed by submission as a New Work Item Proposal ballot in ISO TC201. The draft will then undergo iterative revision until consensus is achieved. It will then undergo a final ISO ballot and then publication.

2. *To ensure the relevant user communities are aware of the ISO Technical Report and how it can improve the validity of their measurements and the development of their products.*

NPL and BAM will disseminate information on the development of the ISO Technical Report to the community as widely as possible. This will be done by giving presentations at at least two international conferences in surface analysis to maximise awareness amongst nanoparticle and electron spectroscopy analysts. After publication of the ISO Technical Report, NPL will submit a summary version to be published as a peer reviewed paper in the journal Surface and Interface Analysis (with open access option). In addition NPL will publish a summary *via* social media (e.g. LinkedIn) in order to increase awareness and uptake by industry.

Impact

Nanoparticles are being increasingly used in a wider variety of commercial applications including consumer healthcare, drug delivery, coatings, electronics and catalysis. These nanoparticles are becoming increasingly more complex and intentionally designed with specific characteristics. Thus accurate and valid characterisation of nanoparticles is increasingly important with a broad array of both academic and industrial laboratories engaging in or specialising in the analysis of nanoparticulate samples.

The outcome of this project will be an ISO Technical Report under the auspices of ISO/TC 201 that will provide clear and comprehensive methods and best practice for the measurement of nanoparticle coating thicknesses using electron spectroscopy techniques. It will create further impact from the results of the EMRP HLT04 BioSurf project which established the underlying metrology of key aspects of nanoparticle coating characterisation. The report will also provide guidance and validated methods via an ISO Technical Report, which will streamline the ability of industry to bring effective nanoparticle based products to market. The engagement with the members of ISO/TC 201 will increase the impact of these efforts and drive progression towards standardisation. This committee has a strong industrial focus, and is the global leader in surface chemical analysis standardisation with international experts respected throughout the scientific community. Industrial participants include Kratos Analytical (UK), SPECS (Germany), ThermoFisher Scientific (UK), the British Standards Institute (UK), AWE (UK), and several other major international companies.

Wider economic impact - Nanoparticles are currently used in an extremely broad array of industries, with applications in fields including catalysis, composite materials, medical devices, diagnostics, and drug delivery, opto-electronics and many others. The use of nanoparticles in medicine and pharmaceuticals is a large and rapidly growing industry. In the field of drug delivery alone, the total market size for nanoparticle/nanocarrier based technologies is expected to surpass $130 billion (USD) over the next 5 years. By providing validated methods for measurement of such coatings and progress towards standardisation of these kinds of measurement, the proposed ISO Technical Report will greatly ease the development of such products and help to meet regulatory requirements.

Nanoparticles also have great potential application as catalysts for a variety of purposes. With an expected global worth of over $30 billion (USD) for the catalyst market within the next ten years the development of coated nanoparticle based catalysts has a significant potential impact.

Wider social impact - The ISO Technical Report will impact on the broader quality of life through the utilisation of coated nanoparticles in the healthcare and medical industries, as well as some potential use in consumer goods, such as sun cream. As previously mentioned, coated nanoparticles for use in medical applications are a large and growing industry, and may significantly impact on early diagnostics and treatment outcomes for major illnesses such as cancer.

Wider environmental impact - This ISO Technical Report will aid in the development of several nanoparticle based technologies which may have direct environmental impact, such as for oil recovery and in the field of photovoltaics and lighting and display technologies. The proposed ISO Technical Report will thus have use in a variety of nanoparticle applications in energy-related markets, leading to significant positive environmental impact.

List of publications

N/A

Project start date and duration:	01 May 2018 and 36 months	
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