



Thematic Actions

Coordinating Universities for the Proposal: UCM and UPM

Title of Action	ICTS of Advanced Electron Microscopy Centre		
Participating partners	UCM, UPM, CSIC, CIEMAT	Other participants	
Personnel involved	J. M. González Calbet (UCM), J. Piqueras (UCM), M. Varela (UCM), J. Llorca (UPM), P. Adeva (CSIC).		
Start date	1-12-2009	End date	31-12-2012
Cluster	Materials for the Future	Other clusters	Heritage, i-Health, Global Change and New Energies
Areas of action	Research / Knowledge Transfer / Teaching Improvement and EHEA Deployment / Local and Territory Interactions.		
Location	UCM Electron Microscopy Centre		
Infrastructures involved	ICTS Advanced Microscopy, ISOM (UPM), Fusion (CIEMAT)		
Keywords	High Resolution Electron Microscopy; Aberration Corrector; Scanning Transmission Electron Microscopy; Dual Beam.		
<p>Objectives:</p> <p>The main purpose of the Materials Section at ICTS Advanced Microscopy, based at UCM CAI Microscopy, is the installation and set-up of:</p> <ul style="list-style-type: none"> Two new ultra high resolution electron microscopes –TEM and STEM, respectively – equipped with aberration correctors and analysis systems by energy dispersion spectroscopy (EDS) and electron energy dispersion spectroscopy (EELS) and Z- contrast (HAADF). These Cs correctors are the elements providing a unique quality to the installation; they are able to obtain images with point-to point resolution below 1 Å (0.05 Å for TEM, will be the first of its kind to be installed in Europe). This action has already been approved by the MICINN and the Community of Madrid. A dual meam system (FESEM-FIB) for micro and nanostructural analysis of materials and mechanical characterisation at the nanoscale (financing is requested for this particular action). <p>ICTS will be used for training of new researchers through MSc and PhD programmes.</p>			
<p>Description of the action:</p> <p>The link between structure and properties is paramount when dealing with the behaviour of materials and attempting to design them with predictable properties. Electron microscopy made a giant leap in the field of characterisation techniques by revealing structural details previously not visible using other techniques. The use of electron microscopy boosted the knowledge of structural materials, with a crucial effect on the field of civil engineering, but also played a central role in the study of functional materials, with technological transcendence. The achieved results and the ever-growing requirements of modern society push the limits in material research to increasingly higher levels of innovation and complexity. The use of spherical aberration correctors, with their associated techniques and software tools, is a fundamental element to solve new challenges and to achieve the strategic objectives described in the Spanish National Plan for Materials (Plan Nacional de Materiales).</p> <p>The requested equipment is a FESEM-FIB, which consists of a field emission scanning electron microscope with an additional column for an ion gun. Both columns can operate simultaneously in a complimentary fashion. Hosting these cutting edge instruments in an environment where the most competent personnel contributes with the scientific and technological know-how seems the best way to ensure their optimum use. The technical maintenance is properly catered for by in-house staff, and justifies the existence of ICTS with special sections focused in the inorganic and organic fields. In this sense, it must be mentioned that the Head of ICTS, Prof. J. M. González Calbet, member of the International Advisory Committee of the 2010 International Conference of Microscopy, with the purpose of ‘consolidating’ a panel of experts in new technologies of electron microscopy, is leading one of the recently awarded projects in the ONSOLIDER-INGENIO 2010 Programme (in its 2009 call for proposals), where seven national groups (three from UCM, one each from universities in Barcelona, Cádiz and Basque country, and one from CSIC) with experience in material characterisation by electron microscopy, will aim to coordinate the activities of a large group of Spanish experts based in different national locations, based on the axis of laboratories already and exhaustively using HREM (Barcelona-Madrid-Cádiz). The purpose is to cater for the educational objectives, providing training and preparation in the use of the next generation of electron microscopes equipped with aberration correctors.</p>			



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<p>Key planned results:</p> <p>The importance of these technological advancements will allow us to obtain information previously difficult to obtain, regarding e.g. light elements visualisation and metal-oxygen regions in oxides, electronic structure determination, description of interphases and surfaces, single doping atoms, defect characterisation, semiconductor characterisation and micro and nanoscale electronics, application of coatings and surface dopants, nanolithography, sample micro-nanomechanisation and nanomanipulation, sample preparation for transmission electron microscopy at fully identified positions (impossible to achieve using other techniques), composition and structure microanalysis with 3D reconstruction. The dual beam system allows the introduction of different systems in its chamber to perform mechanical tests inside it. This possibility opens up a new field of mechanical tests at nano and mesoscopic scale which cannot be carried out by any other means, since the samples can now be prepared, manipulated and tested inside the microscope itself.</p>	
<p>Rationale for the action:</p> <p>The enormous breakthrough that this new technology represents is clearly reflected in the immediate response of the international scientific community to these new generation microscopes. Globally, there aren't many infrastructures similar to that at UCM. This type of instrument will qualify the approved ICTS as a truly singular site, and will enable a coordinated effort under the best possible methodological conditions throughout the whole study process, from sample preparation up to the most advanced mathematical treatment for structure solving. Furthermore, the option of installing remote controls will make this ultra high resolution microscope available for use in Spanish regions as far apart as Catalonia, Andalusia or the Basque country. Besides, at present there is no other dual beam microscopy system (FESEM-FIB) in the Community of Madrid, and are very few in the rest of Spain. This equipment in particular, with a mechanical testing system designed to be attached inside the microscope, is one of the few installed worldwide. Therefore, it is a large infrastructure that will provide new opportunities for all the research groups and companies involved in the Science of Materials in Spain.</p>	
<p>International aspects:</p> <p>As already mentioned, there are very few types of equipment in the world with these features. The installation would boost the quality of the research carried out by a large number of research groups already established in the Moncloa Campus, contributing to their internationalisation and quality improvement, while increasing their potential to attract foreign students and scientists, given the singularity of ICTS. Permanent contacts have already been established with several facilities and centres in use or currently under construction. Among them, the existing collaboration between IMDEA-Materials (UPM) and CAI Microscopy (UCM) with IMDEA-Nanotechnology (UAM-UCM) and ICTS Fusion (CIEMAT). Additional contacts have been established for collaboration purposes with other projects within the ESFRI European Roadmap. Some members of the research group belong to a EU project on material characterisation by electron microscopy, while other members maintain a permanent collaboration with the Oak Ridge Microscopy Centre (USA).</p>	
<p>Planned impact:</p> <p>Recent advances in instrumentation enable an extraordinarily in-depth look at the relationships between the structure and properties of matter, which are a benefit to both basic and applied knowledge. The scientific challenges that we face nowadays are becoming more and more multidisciplinary; hence the necessity to consolidate an ICTS where different research groups in the Science of Materials, from different places throughout Spain, can participate and obtain micrographs working from their research centres, thanks to remote control equipment.</p>	
<p>Other institutions interested:</p> <ul style="list-style-type: none">• World-class companies such as Glynwed Iberica Pipe Systems, Abengoa Solar NT, and AIRBUS SPAIN.• Jeol Ltd is collaborating with ICTS in the set up of the new microscopes.• Jeol Ltd, Fei and Gatham are participating in the training courses for young researchers.• More than 300 scientists from several groups at the UPM Structural Materials Centre, UCM CAI Microscopy, CENIM, CIEMAT, Building Sciences Institute 'Eduardo Torroja', UPM Institute of Optoelectronic Systems and Microtechnology, UPM Solar Energy Institute, IMDEA-Materials, CSIC (institutes at Moncloa campus), Technical University of Catalonia, and UPM Biomedical Technology Centre.	