Thematic Actions

Coordinating Universities for the Proposal: UCM and UPM

Title of Action	**Workshops for the Development of New Thin Film Materials**		
Participating partners	UCM, UPM, CIEMAT	**Other participants**	
Personnel involved (indicate institution)	Santamaría (UCM), E. Muñoz, E. Calleja (ISOM, UPM), IMDEA Materiales (UPM), CIEMAT		
Start date	2010	**End date**	2012
Cluster	Materials for the Future	**Other clusters**	Global Change and New Energies
Areas of action	Research / Knowledge Transfer / Teaching Improvement and EHEA Deployment		
Location	Faculty of Physics (UCM)-ISOM		
Infrastructures involved	ISOM, Advanced Microscopy		
Keywords	Oxide electronics; Semiconductors; Superconductors; Magnetoresistance		

Objectives:

This research will focus on the preparation of new thin film materials for the development of nanoelectronic sensors and devices. Characterisation will encompass the combined use of high resolution electron microscopy in the STEM-EELS ICTS available on the Campus, x-ray dispersion and absorption spectroscopies, polarised neutron reflectometry and magnetic and transport measurements. The processes of nanofabrication will be conducted at the ISOM ICTS also on the Campus. We propose to make use of the new phenomena appearing at the complex oxide interfaces to fabricate devices with new functionalities.

Description of the action:

Correlated transition metal oxides are a wide family of materials in which almost every possible solid state may occur, including ferromagnetism, superconductivity, multiferroics, etc. Many of these compounds share a common perovskite structure with very similar lattice parameters, which allows the preparation of hybrid materials made from alternating layers with atomically sharp interfaces. In these artificial structures, very different or even antagonistic ground states (such as magnetism and superconductivity) may be brought into direct contact at the interfaces. The coupling or competition of very different states gives rise to interesting effects and novel properties, allowing the design of artificial materials (not existing in nature) with new functionalities.

Key planned results:

The planned scientific outcome is the control of the electronic structure of interfaces to obtain specific functionalities. We propose to utilise these results to implement practical devices in oxide electronics. We will produce magnetic devices such as magnetic tunnel junctions (very relevant for information storage) or magnetic field controlled field effect devices (transistors) that will be useful as new sensors.

Rationale for the action:

During the 20th century, electronic devices have had huge impact on our quality of life, revolutionising communications, computing, manufacture and transport. Modern society has generated a need for smaller electronic devices: the new electronics markets require higher integration intensity along with lower power consumption and higher speed. This has driven researchers and technologists to explore new production protocols in which dimensions are reduced down to the size of a few tens of atoms. This race, in which devices are made smaller and smaller, has raised problems that the semiconductor industry cannot solve. This is fundamentally because the limit has been reached in which the laws of the Classical Physics ruling the operation of current devices are no longer valid. Nanoelectronics has emerged as a multidisciplinary field of enormous scientific and technological relevance aimed at addressing the changes occurring in device properties when dimensions are reduced to the nanometer range. In this framework, oxide electronics is a scientific and technological field oriented to surmount the limitations of semiconductor devices using thin films and nanostructures made of correlated transition metal oxides. In this research, we will examine the potential of correlated oxides for the next generation's nanoelectronics, exploiting the multifunctional character linked to their complex nature.

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International aspects:

The ability to control matter down to the atomic and electronic levels and to understand the complex phenomena resulting in these materials from (in principle) simple ingredients, have been identified as two of the major challenges for the next ten years by the US Academy of Sciences and by the Advisory Committee of the US Department of Energy. In the same direction, the new phenomena occurring at the interfaces between complex oxides have been identified by the scientific journal *Science* as one of the major breakthroughs in science in 2007. As such, this field constitutes one of the priority areas of the FP7 in Science and Technology. This has motivated new work in this area in important research institutes and technology centres in Europe, the USA and Japan.

Planned impact:

The planned impact is the creation of a scientific and technological hub in our Campus, capable of producing transition metal oxide devices to face the new challenges of oxide electronics. Its activity will focus on the creation of prototype devices for specific applications. Strategically it will be of interest through training human resources in an emerging area of high technological and scientific potential.