Domain: MATERIALS, PHYSICAL AND NANOSCIENCES (MPNS)

Materials, Physical and Nanosciences are equally important fields in advancing science.

The Domain *Materials, Physical and Nanosciences* is home to materials science and physics, extending from conception through production, characterization, examination, evaluation, fabrication, joining to actual application and service, including related databases, simulation tools, standards and inspections. The Domain covers the full range of materials on length scales down to the nano-meter and atomic range, including surface modifications and the corresponding change in physical properties is also targeted at. The Domain includes exploratory basic research as well as applied research in physics as a key to understanding the laws governing the behaviour of matter and energy.

The following examples illustrate aspects of research in this Domain. The scope of the Domain is not restricted to these activities but will adjust to changes arising from novel ideas within European research community.

New developments in industrial technology and technology driven projects requiring the synthesis of new material. In this context, materials science, physics and nano-science or combinations thereof will be supported from this domain. Especially physics underpins many industries and technological processes; it contributes to the synthesis of new materials and to a broad variety of new devices based on the progress made in areas such as optics, plasma physics, surface physics, materials simulation and others.

Emerging Technologies for energy supply, telecommunication bio-technology and related sectors which trigger innovative progress in conventional sectors such as power technology , transport, aerospace, lighting, and monitoring or the establishment of completely new technology areas.

Cultural Heritage: The sciences contributing to this Domain are part of Cultural Heritage as they answer the most fundamental scientific questions related to the ageing of various kinds of objects of art. Therefore the Domain is also responsible for Actions in Cultural Heritage focusing on restoration and conservation of ancient architecture, built environment and artifacts.

Multidisciplinary Research: Materials science, Physics and, to an even larger extent, nano-science are multidisciplinary research fields. The Domain maintains active interaction with other COST domains on many relevant issues such as, for example, environment, global warming and social aspects of nanotechnology.

By recognizing the huge potential of nano-sciences in such different areas the Domain encourages multidisciplinary actions and cooperates closely with the other Domains. Therefore, new ideas and initiatives are welcome as well as all ideas with high interdisciplinary elements and close links and overlaps with other Domains.

Action 540 - Photocatalytic technologies and novel nanosurfaces materials – critical issues (PHONASUM)

2006 - 2010 Chair: Dr František PETERKA (CZ)

The **main objective** of the Action is to via a concerted European effort increase the fundamental knowledge of nanocrystalline photoactive materials and development of new products, which utilize self sterilizing and self cleaning photoactive materials in commercial applications. The Action will also concentrate on the development of EU standards for the characterization of photocatalytic materials.

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Action 541 - Semi-solid Processing of Steels (Thixosteel)

2006 - 2010 Chair: Dr Ahmed RASSILI (BE)

The **main objective** of the Action is to develop an industrial applicable process for the thixoforming of steel alloys, as well as for the control of the whole production chain, including material and tool developments.

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Action 542 - High Performance Energy Storages for Mobile and Stationary Applications (HPSMT)

2006 - 2010 Chair: Dr Dalik SOJREF (DE)

The **main objective** of the Action is the development of high performance energy storage systems and their implementation in mobile and stationary applications in transportation and energy technologies

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Action 543 - Research and Development of Bioethanol Processing for Fuel Cells (BIOETHANOL)

2006 - 2010 Chair: Pr Markku LAMPINEN (FI)

The Action focuses on developing new technologies for bioethanol that can be used effectively in small-scale fuel systems of electric power output between 0.5 and 10 kW. The technologies cover low-temperature bioethanol reforming in hydrogen selective membrane reactors and cleaning methods as well as their combinations with any type of low-temperature fuel cell.

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Action P15 - Advanced Paramagnetic Resonance Methods in Molecular Biophysics

2005 - 2010 Chair: Pr Sabine VAN DOORSLAER (BE)

The **main objective** of the Action is to initiate a concerted European effort to develop new electron paramagnetic resonance (EPR) instruments and methodologies in order to determine the structure, dynamics and structure-function relationships of biological systems.

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Non-COST participation: Institute of Organic Chemistry - Novosibirsk (RU), Kazan Physical Technical Institute (RU)

Action P19 - Multiscale modeling of materials

2006 - 2010 Chair: Pr Matti ALATALO (FI)

The **main objective** of the Action is to increase the basic knowledge on technologically important materials and processes of their treatments and to provide a scientific basis for improving their macroscopic properties.

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Action P20 - Large-Eddy Simulation for Advanced Industrial Design (LES-AID)

2006 - 2010 Chair: Pr Bernard GEURTS (NL)

The **main objective** of the Action is to develop large-eddy simulation strategies for turbulent flows in industrial applications involving combustion, external/internal flows and multi-phase fluids.

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Action P21 - Physics of Droplets

2006 - 2010 Chair: Pr Nicolas VANDEWALLE (BE)

The Action **aims** at improving the fundamental understanding of the physics of droplets (production, transport, coating and stock), from the microscopic scale to our macroscopic world. Fundamental information will provide tools for broad practical applications reaching from the traditional food industry to cutting-edge technologies.

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Action MP0601 - Short Wavelength Laboratory Sources

2007 - 2011 Chair:

Our ability to manipulate short wavelength radiation (~0.01–100nm, equivalent to ~120keV–12eV) has increased significantly over the last three decades. This has lead to major advances in applications in a wide range of disciplines such as: the life and medical sciences, including cancer-related studies; environmental science, including studies of pollution and its effects; archaeology and other cultural heritage disciplines; and materials science. Although expansion in application areas is due largely to modern synchrotron sources, many applications will not become widespread, and therefore routinely available as analytical tools, if they are confined to synchrotrons. This is because synchrotrons require enormous capital and infrastructure costs and are often, of necessity, national or international facilities. This seriously limits their scope for applications in research and analysis, in both academia and industry. How many universities, research institutes or even industrial laboratories would have electron microscopes if electron sources cost 100M€ or more? Hence the need to develop bright but small and (relatively) cheap x-ray sources, not to replace synchrotrons but to complement them. It is the purpose of this COST Action to facilitate such developments.

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Action MP0602 - Advanced Solder Materials for High Temperature Application (HISOLD)

2007 - 2011 Chair:

The **focus** of the COST Action is the investigation of Pb-free replacements for high-Pb solders for high-temperature applications. This comprises a study of the chemical, physical and mechanical properties of alloys containing a large number of permutations of different alloying elements. A multiscale approach will be used:

- meso-scale: The application of thermodynamics and kinetics to the study of alloying behaviour; the development of materials property databases.
- macro-scale: The creation of a phenomenological description of corrosion and deformation processes occurring in a solder joint during fabrication and service,

- micro- (nano-) scale: The investigation by experiment and modelling of the initial stage of the formation of intermetallic phases at the solder/substrate interface. This will involve the consideration of diffusion.

This will be most efficiently achieved through coordinated international cooperation providing a basis for interdisciplinary research. The action will increase the basic understanding of alloys that can be used as Pb-free alternatives to high-temperature solders for practical applications, for example in the aerospace and automotive industries.

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Action MP0603 - Chemical imaging by means of CARS-microscopy (MicroCARS)

2007 - 2011 Chair:

The **aims** of the proposed Action are to ascertain scientific exchange between European experts that have significantly contributed to the development of a novel laser-based microscopy method, Coherent Anti-Stokes Raman Scattering (CARS) microscopy, and to establish it among a broader scientific community in nanobiotechnology. The Action has a highly interdisciplinary character: advanced physical light interaction mechanisms will be explored and employed to provide fundamental structural and chemical information on a nano-scale for the benefit of material and life sciences. CARS-microscopy allows visualization of molecules under natural conditions without the need for exogenous markers. Instead, their intrinsic vibrations are probed, carrying information on both molecular composition and physical state. CARS-microscopy is accomplished with exceptionally high 3-D resolution, through thick samples, and with negligible photo-damage thanks to the nonlinear character of the CARS process and probe beams in the near-infrared regime. The Action will demonstrate the potential of CARS-microscopy by compelling applications, involving 3-D mapping of the organization/dynamics of molecules in material and biological nanostructures.

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Action MP0604 - Optical Micro-Manipulation by Nonlinear Nanophotonics

2007 - 2011 Chair:

The **objective** of this Action is to establish active links between European laboratories working in the field of optical manipulation and related applications and to foster and accelerate long-term development of this field in Europe. The goal is to increase knowledge about the basic mechanisms of optical trapping and to develop novel methods of manipulation, micro-patterning and imaging, to be exploited in the future bio-medical technology and in micro-mechanics. The scientific innovation concerns: basic mechanisms of the mechanical light-matter interaction; holographic techniques;

nonlinear optical methods in microscopy and trapping. The potential impact on technology concerns the implementation of advanced equipment and devices for: nondestructive and non-invasive manipulation and imaging of micro-objects; patterning and templating of micro-devices; measurements in microfluidics. The scientific exchange resulting from the Action will facilitate the interconnections between these topics to obtain new results in the field of optical manipulation as well as to pave the way to new scientific understanding and technological advancement in the forthcoming era of nanobiotechnology.

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