

Projet Final Report

Final Publishable Summary Report

Grant Agreement number: 219433

Project acronym: NANOSCI-E PLUS

Project title: Transnational call for collaborative proposals in basic nanoscience research

Funding Scheme: Coordination and Support Action

Period covered: from 01/01/2008 to 31/12/2012

Name of the scientific representative of the project's co-ordinator, Title and Organisation:

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Executive summary

NanoSci-E+ is the direct outcome of the work initiated within NanoSci-ERA, a consortium created in 2005 under FP6, with the objective of promoting the integration of the national research communities in nanoscience throughout the ERA. The main accomplishment of NanoSci-ERA is the transnational call launched in 2006 with a thematic focus on the "generation of new knowledge on the fabrication, study and control of individual nano-objects". Capitalising on the robust coordination mechanisms and implementation modalities created for the NanoSci-ERA call, the objective of NanoSci-E+ is the implementation and follow-up of a second transnational call for collaborative proposals in nanoscience.

Thanks to the repeat of multi-partner joint actions, an efficient coordination between research funding actors should develop in the long run. In this respect, the experience acquired through the first call gives a totally different character to the coordination work, where the contents and strategic aspects gain the upper hand on more administrative issues. The NanoSci-E+ action should also result in a better interfacing of the national programmes where the joint call, designed to be a seamless extension to each of them, will constitute the pivotal element linking them all. By serving as a reference, it should make possible to easily set up bi- or multi-lateral initiatives between sub-groups of participants willing to deepen cooperation on specific topics where the participation of a larger pool of countries does not answer a strategic need.

The beneficiaries of NanoSci-E+ are the French National Centre for Research and Science (CNRS), coordinator of the consortium, French National Agency for Research (ANR), The Austrian Science Fund (FWF), the Academy of Finland (AKA), the German Research Foundation (DFG), Israel Science Foundation (ISF), the Italian National Council of Research (CNR-INFN), the Dutch Foundation for Fundamental Research on Matter (FOM), the Dutch Technology Foundation (STW), the Portuguese Foundation for Science and Technology (FCT), Slovak Academy of Science (SAS), the Foundation for Knowledge Madridmas (fmi+d), Spanish Minister for Economy and Trade (MINECO), the British Engineering and Physical Science Research Council (EPSRC), Science Foundation Ireland (SFI), the Polish National Centre for Research and Development (NCBiR).

The call organised by NanoSci-E+ was open to "frontier research projects that address the issue of interfacing functional nano-objects or nano-materials". The projects expected to fit within the scope of the call are transverse to many disciplines of nanoscience and therefore accessible for the researchers of all the participating countries.

The funding scheme set up for the call was designed in order to ensure that the most deserving projects are funded, in relevance to the prescribed evaluation criteria and no other consideration. This scheme relies on a common pot to which a majority of the participating countries contribute. Mutualizing part of the budget aims to avoid trade-offs where the selection of projects will be determined by the availability of funds, whereas the objective is to support the highest quality research projects.

The structure of the call was based on two submission/evaluation stages (Letters of Intent / Full Proposals). The assessment of the proposals was completed remotely and during evaluation panel meetings which have resulted in a ranking of the submitted proposals. The role of the NanoSci-E+ consortium was to create a framework for the evaluation work, but it did not intervene in any way in the evaluation process, with a refereeing entrusted to an independent international panel of experts in nanoscience.

208 Letters of Intent were submitted. The objective of the call was to fund around 25 projects and has actually resulted in the funding of 24, with a contribution of close to 6 M€ (or 31.3% of the total budget) from the European Commission. From its side, the consortium has contributed by ca. 13 M€, part of it was mutualized in the common pot.

The transnational projects have started in the second semester of 2009. In 2010, all projects have been granted the first part of the funding. In order to implement the scientific follow-up of the projects, a review conference was held in June 2011 at Trinity College in Dublin. This Conference

was aimed at carrying out the assessment of the projects progress towards their initial objectives, and a review of each project was made. Different other funding to projects has been transferred in 2011 and 2012. A final report for each project will be asked in April 2013. NanoSci-E+ will be finished as a project, however, as most of transnational projects began late, most of them will finish only after the end of the NanoSci-E+ project.

Project context and objectives

NanoSci-E+ is the direct outcome of the work initiated within NanoSci-ERA, a consortium created in 2005 under FP6, with the objective of promoting the integration of the national research communities in nanoscience throughout the ERA. The main objective of the NanoSci-ERA is to promote the collaboration and integration of the national research communities in nanoscience throughout the ERA (European Research Area), and thus overcome the fragmentation of nanoscience research along national or regional lines. Capitalising on the robust coordination mechanisms and implementation modalities created for the NanoSci-ERA call, the objective of NanoSci-E+ is the implementation and follow-up of a second transnational call for collaborative proposals in nanoscience.

This focus is seen as fundamental for long-term research, for developing nanoscience as a knowledge-generating activity without topical restrictions, for allowing the emergence of strong bottom-up (community-driven) thematic programmes. The interdisciplinary character of nanoscience, including physics, chemistry, materials science, biology, gives an additional dimension and challenge to NanoSci-ERA, in bringing these communities together on a European scale.

The ERA-net had 3 operational objectives:

- An effective and durable coordination of the partner and associate organisations
- The development of a coherent scientific policy on the multidisciplinary development of nanoscience through the ERA
- A concerted outreach to the societal players

The consortium initially had 12 participating countries: Austria, Finland, France, Germany, Israel, Italy, The Netherlands, Poland, Portugal, Slovakia, Spain, and the UK. Ireland then joined in 2009 when the consortium applied for an ERA-Net+ extension. The ERA-net is coordinated through the CNRS and the ERA-net website can be found here: <http://www.nanoscience-europe.org/>

The call organised by NanoSci-E+ was open to "frontier research projects that address the issue of interfacing functional nano-objects or nano-materials". The projects expected to fit within the scope of the call are transverse to many disciplines of nanoscience and therefore accessible for the researchers of all the participating countries.

Main S&T results/foregrounds

The objective of the project was to launch a Call. The objective of the call was to fund around 25 projects and has actually resulted in the funding of 24, with a contribution of close to 6 M€ (or 31.3% of the total budget) from the European Commission. From its side, the consortium has contributed by ca. 13 M€, part of it was mutualized in the common pot.

List of projects financed within the Call

- **Project 104_NanoActuate**

Abstract : Plasma membrane proteins show complex dynamic ordering, such as clustering, on a nanoscale level, which typically changes after external stimulation. The mechanisms of these processes and the consequences for signal transduction are of great interest as extracellular signalling events are translated into cells via the plasma membrane. We aim to actuate plasma membrane proteins in a controlled fashion using rationally designed nano-objects and to visualize this interfacing process on the nanometer scale, yielding new insights into cell signalling via the plasma membrane. Rationally designed nano-objects with controlled interfaces to actuate proteins in membranes specifically address the call requirement for ground-breaking research in nanoscale interfaces. The nano-objects bridge the gap between studies on isolated proteins, that cannot account for protein clustering in the native environment, and whole cell studies, that do not allow the controlled actuation of the nano-clusters.

Team :

Vinod SUBRAMANIAM, MESA+ Institute for Nanotechnology, Enschede, Biophysical Engineering Group (NL) – coordinator

Quentin HANLEY, Nottingham Trent University, Nottingham (UK)

Peter VERVEER, Max Planck Institute of Molecular Physiology, Dortmund (DE)

Luc BRUNSVELD, Technical University Eindhoven, Eindhoven (NL)

*Start date*¹: June 2009

End date: September 2013

Total budget: 879 942 €

- **Project 054_QD2D**

Abstract :

Team :

Martin GELLER, Department of Physics and CeNIDE, University of Duisburg-Essen (DE)

Manus HAYNE, Department of Physics, Lancaster University (UK)

Dieter BIMBERG, Institut für Festkörperphysik, Technische Universität Berlin (DE)

Jens GARLEFF, Department of Physics, Eindhoven University of Technology (NL)

Start date: June 2009

End date: October 2013

Total budget: 864 818 €

- **Project 189_INOFEO**

Abstract : The interaction between nano-objects of different dimensionality, e.g. electrostatic Coulomb-coupling of zerodimensional quantum dots (QDs) to two-dimensional (2D) systems is of fundamental interest and of great relevance for future charge-based memories. This interaction shall be studied here. The complementary expertise of the partners will allow the innovative approach to study for the first time Sb-based QDs combined with split-gate structures. Precise control of the charge-state of a single QD will be possible. Sb-based QDs in type-II heterostructures have strong hole confinement yielding a potential retention time of many years at room temperature, enabling the analysis of the influence of charged QDs on a 2D system up to 300 K. In the mid-long term perspective, the results will be important for future generations of memories: knowledge of the interaction of a 2D system with a single QD will allow us to reach the ultimate limits of charged-based memories (in particular Flash).

¹ The start date and end date depend on each contributor. Only the first chronological start date and last end date are mentioned.

Team :

Luisa DE COLA, Westfälische Wilhelms-Universität Münster Physikalisches Institut (DE) - coordinator

Wilfred VAN DER WIEL, MESA+ Institute for Nanotechnology, University of Twente (NL)

Andrew GRIFFITHS, Institute de Science et d'Ingénierie Supramoléculaire (ISIS) CNRS UMR (FR)

Nelsi ZACCHERONI, Dipartimento di Chimica "G. Ciamician", University of Bologna (IT)

Start date: June 2009

End date: May 2014

Total budget: 839 575 €

- Project 001_ SENSORS

Abstract : SENSORS aims to generate new knowledge to underpin the development of new interfacing protocols for nanoscale organic logics. SENSORS relies on supramolecular approach to the design, synthesis and use of solution-processable Supramolecularly Engineered Nanostructured Materials (SENMs) with electronic function, to seek new solutions for solving key interfacing issues of wires and transistors prototypes (molecular-/meso-scale). SENSORS matches the scopes of NanoSciEra as its objectives are:

1. Synthetic and supramolecular chemistry of functionalized conjugated 1D & 2D systems
2. Development of hierarchical protocols for interfacing and self-organisation of electroactive SENMs from sub-nm scale upwards
3. Top-down & bottom-up electrodes nanofabrication with gaps down to 30 nm
4. Interfacing of SENMs with both substrate and electrodes
5. Fabrication of supramolecular wires & Field-Effect Transistors. Our ultimate goal is to reach carrier mobilities ≥ 4

Team :

Paolo SAMOR, Institut de Science et d'Ingénierie Supramoléculaires (I.S.I.S.), Strasbourg, Université Louis Pasteur (FR) – coordinator

Klaus MÜLLEN, Max-Planck Institut for Polymer research, Mainz (DE)

Richard H. FRIEND, Cavendish Laboratory/Department of Physics, Cambridge - University of Cambridge (UK)

Franco CACIALLI, London Centre for Nanotechnology, London - University College London (UK)

Start date: June 2009

End date: 2013

Total budget: 878 964 €

- Project 008_ NANO-BLOCK

Abstract : The objective of the project is the growth and manipulation of semiconducting (silicon) and metallic (gold) nanoobjects (nanodots, nanowires) in/on an oxide matrix in order to fabricate devices in which the different fabric elements will be interfaced to create a new generation of nano-transistors, nano-memories and nano-emitters. The placement of these nano-objects will be controlled by templated-self-assembly, i.e. the combination of conventional lithography and self-assembled block copolymers (BC). By combining "bottom up" self-assembled BC thin films with "top-down" patterned templates it is possible to precisely control the positioning of nanodot and nanowire arrays and even of single nanodot or nanowire in a well-defined location. This will provide a unique opportunity to study the interfacing of these nano-objects and to achieve their electrical and optical coupling both at nanoscale level (individual behavior) and on large assembly of nano-components (macroscopic behavior)

Team :

Michele PEREGO, Laboratorio Nazionale MDM, CNR-INFM (IT) – coordinator

Gerard BENASSAYAG, Centre d'Elaboration des matériaux et d'études structurales CEMES-CNRS (FR)

Paolo PELLEGRINO, Universitat de Barcelona (ES)

Start date: October 2009

End date: October 2012
Total budget: 623 400 €

- Project 092_MARVENE

Abstract : Bioengineering research is exploring molecular and cell therapies alternative to surgical nerve grafting for the treatment of severe peripheral nerve injuries. However, to date there has been no progress of undoubted clinical benefit. The recent advances in nanoscience may provide new therapeutic possibilities as alternatives/supplements to established surgical techniques. Specifically, the MARVENE project is concerned with the use of magnetic nanoparticles (MNPs) as functional nano-objects to enhance the nerve regeneration and provide guidance for the regenerating axons. MNPs could open the frontiers for new therapies based on the exploitation of the mechanical forces acting on MNPbound neurons to promote axonal elongation/growth. Furthermore, the realization of MNPs functionalised with neurotrophic factors offer distinct possibilities for novel molecular therapy and when bound to mesenchymal stem cells, MNPs may form the basis for more effective cell therapy.

Team :

Vittoria RAFFA, Scuola Superiore di Studi Universitari e Perfezionamento Sant'Anna (IT) - coordinator

Gerardo GOYA, Nanoscience Institute of Aragón (ES)

Lijun WANG, Institute for medical science and technology, University of Dundee (UK)

Gerburg KEILHOFF, Institute of Medical Neurobiology/ university of Magdeburg (DE)

Start date: June 2009

End date: September 2012

Total budget: 837 500 €

- Project 132Q-OptInt

Abstract : Quantum information can take different forms, among which photon polarization is most useful for long distance communication while single electron spin is most useful for qubits interactions. However, no quantum interface between a single-electron spin and a single-photon polarization has yet been demonstrated. In this project we suggest to interface optically active quantum dots generating single photons with gate-controlled quantum dots controlling single electron spins. In our scheme, the electron spin quantum dots are controlled by electrical gates and the coupling between the two types of quantum dots will also be controlled by nanometer scale gates. Our ultimate aim is to coherently interface two quantum dots with different functionalities: an optically active quantum dot with a gate defined quantum dot via a dynamic control of the local potential to convert single electrons into single photons.

Team :

Valery ZWILLER, Kavli Institute of Nanoscience, TU Delft (NL) – coordinator

Elisabeth REIGER, Institute for Experimental and Applied Physics, University of Regensburg (DE)

David GERSHONI, The Physics Department and the Solid State Institute, Technion (IL)

Erik BAKKERS, Philips Research Laboratories (NL)

Start date: June 2009

End date: April 2013

Total budget: 660 000 €

- Project 049_FENOMENA

Abstract : The goal of this project is to achieve ultrafast and efficient interaction and controlling of nanomagnets with light and to develop sub-ps near-field magneto-optics and opto-magnetism. In particular, the project aims to realize both ultrafast (10^{-12} s and faster) optical control of

magnetism at the nanoscale and ultrafast sensitive detection of spins with nanometer spatial resolution, using suitable nano-optical structures such as resonant nano-antennas and hollow nanopylramids. An ambition of the research program is to initiate the development of novel technologies for unprecedented fast all-optical recording and processing of magnetically stored information. The research is in the scope of the call because it a) deals with the functional coupling between a nano-object (nanomagnet) and a larger object (light) through an identified nano-specific gateway (specially designed nano-optical structures) and b) provides enabling steps towards interfacing nanomagnets and light.

Team :

Alexey KIMEL, Spectroscopy of Solids and Interfaces/Institute for Molecules and Materials (NL)

Marco FINAZZI, Dipartimento di Fisica/Politecnico di Milano (IT)

Bert HECHT, Experimental Physics V/Physics Institute, University of Würzburg (DE)

Start date: June 2009

End date: October 2014

Total budget: 660 000 €

- Project 115_ NANOTRUCK

Abstract : A major obstacle in the use of many chemicals for diagnosis or treatment is the lack of tissue specificity. A tag for molecular imaging or a drug-carrying system would have to circulate in the blood stream undetected by the immune system and would have to recognize the desirable target and gives a detectable signal or delivers the drug in it. This NANOTRUCK project intends to develop an innovative kind of multifunctional gold nanoparticles loaded with fluorescent and tumoral markers, cell penetrating peptides and RNAi complementary to the proto-oncogene myc. This biofunctionalization will allow the interaction between NPs and biological systems, ranging from in vitro cultured human cells to in vivo animal models (primitive Hydra and complex vertebrate mouse). This new nanoplatform will allow the targeting and detection of tumor cells and also the study of cellular response against gene tumoral therapy, converting it in a potent tool for the emerging area of theragnostics.

Team :

Manuel Ricardo IBARRA GARCÍA, Instituto de Nanociencia de Aragon-University of Zaragoza (INA) (ES) – coordinator

Catherine BERRY, Centre for Cell Engineering (CCE)-University of Glasgow (UK)

Claudia TORTIGLIONE, Istituto di Cibernetica “E.Caianiello” (ICIB), Consiglio Nazionale delle Ricerche (IT)

Furong TIAN, Helmholtz Zentrum München-IHB (DE)

Pedro BAPTISTA, CIGMH/DCV; Fundação FCT/UNL (PT)

Start date: June 2009

End date: November 2012

Total budget: 888 636 €

- Project 142_ NANOSPEC

Abstract : Plasmonic nanostructures will be interfaced with carbon nanotubes in order to measure electrical transport while simultaneously monitoring structural and chemical changes through plasmon-enhanced Raman scattering. By using plasmonic structures interfaced to nanotubes, we will remove the limitations of resonant Raman spectroscopy and will be able to study fundamental aspects of e.g. current limitation in nanotubes without complications related to changes in resonance conditions, as well as providing fundamental information concerning the nanotube/nanoantenna interface. The team consists of four groups with complementary expertise in all key aspects of the project. The devices to be developed in the course of the collaboration will serve as a test bed for interfaces between single molecules and nanoantennas that are promising for fundamental studies in molecular electronics as well as for single-molecule detection.

Team :

Eleanor CAMPBELL, School of Chemistry (UK)
Aaron LEWIS, NanoPhotonics/Hebrew University (IL)
Stefan MAIER, Physics/Imperial College (UK)
Stephanie REICH, Physics/Free University of Berlin (DE)
Start date: January 2009
End date: April 2013
Total budget: 874 812€

- Project 163_MaECENAS

Abstract : We aim to demonstrate that it is possible to move vertically and horizontally nano-objects by coupling them to photoactive self-assembled monolayers (SAMs) of “light powered molecular cargo lifters”. Molecular rods incorporating azo units and organized in SAMs, undergo efficient photoisomerization, producing cooperative molecular movements able to express a controlled mechanical work. By integrating the expertises of different research groups, we intend to harness the force expressed by azo SAMs, in order to i) move vertically nano-particles sitting on the azo SAMs, and ii) move laterally nano-particles, by sweeping across the surface patterns formed by alternating cis and trans isomers. The patterns are generated by periodic interference gratings. The experimental data will be interpreted with the help of theoretical models. This work can lead to results relevant for short term application in moving nano-objects in three dimensions.

Team :

Maria Anita RAMPI, Chemistry Department, University of Ferrara (IT)
David CAHEN, Department of Material Science, Weizman Institute (IL)
Stefano CORNI, INFN National center (IT)
Marcel MAYOR, Institute for Nanotechnology (DE)
Start date: June 2009
End date: April 2013
Total budget: 818 964€

- Project 178_ACEPLAN

Abstract : Metal surfaces can support so called surface plasmons, density waves of free electrons. These plasmon waves can interact with light, opening the way to a novel area of optics, namely plasmonics. When the metal surface is nanostructured, a possibility for true nanoscale optics emerges. In this work we aim to alleviate or even remove the unavoidable absorption losses caused by the metal by amplifying the plasmon waves with semiconductor quantum wells and dots, thus demonstrating low-loss plasmonic components. They will be designed by novel electromagnetic simulation methods developed during the project, running on a supercomputer cluster. We will also use this approach to design and fabricate novel wide-band low-loss or even lossless metamaterials, highly promising structures with a negative refractive index that can for example slow or even stop incoming light pulses.

Team :

Janne SIMONEN, Optoelectronics Research Centre, Tampere University of Technology (FI)
Ortwin HESS, Advanced Technology Institute and Department of Physics, University of Surrey (UK)
Antonella BOGONI, National Laboratory for Photonic Networks, CNIT (IT)
Start date: June 2009
End date: October 2012
Total budget: 548 023 €

- Project 011_LECSIN

Abstract : The project focuses on the control of radiative emission of Erbium ions in photonic crystal nanostructures made of crystalline Silicon, with the goal of achieving laser emission around 1.54 micron wavelength. To this purpose, photonic crystal waveguides and nanocavities will be fabricated in Si membranes containing Erbium ions. Photonic structures will be designed such that

the high-Q cavity modes be resonant with the narrow lines corresponding to Er³⁺ emission, in order to tailor the radiative dynamics and to enhance optical gain. Micro-photoluminescence and pump-probe experiments under suitable pumping conditions will probe the radiative emission of Er³⁺, to achieve net gain and lasing threshold. Theoretical studies of Er³⁺ emission coupled to nanocavity modes will allow exploring cavity quantum electrodynamic effects. The proposal builds on a new partnership by leading groups with complementary expertise in Silicon photonics, nanotechnology and nano-photonics, quantum optics.

Team :

Francesco PRIOLO, MATIS CNR INFM (IT)

William WHELAN-CURTIN, School of Physics and Astronomy, University of St Andrews (UK)

Matteo GALLI, Dipartimento di Fisica "A. Volta", Università degli Studi di Pavia (IT)

Alexia AUFFEVES, Institut Néel, CNRS (FR)

Start date: June 2009

End date: September 2012

Total budget: 810 151 €

- Project 124_ INTERNET

Abstract : We approach the problem of interfacing nanoscopic molecules with macroscopic electrodes by using nanoscale intermediates. Our multiple-scale architecture, based on two-dimensional arrays of nanoparticles and metallic nanowires, provides reliable and robust access to electrical, optical and mechanical properties of molecular systems. We will initially explore our device platforms for benchmark molecules to obtain fundamental knowledge on hard-soft interfacing. Next, we interface spin transition systems to obtain dramatic changes of device properties under external stimuli (temperature, stress, electric fields), addressing the fascinating challenge to contact a molecule without losing its functionality. Our results will enable us to select molecular candidates for future sensor applications in functional arrays. Specifically, we will explore a hydrogen gas sensing device, fully based on functional nano-objects (nanoparticles and functional molecules).

Team :

Sense Jan VAN DER MOLEN, Kamerling Onnes Laboratory, Leiden University (NL)

Mario RUBEN, Institute of Nanotechnology, KIT (DE)

Bernard DOUDIN, IPCMS/ULP UMR 7504 (FR)

Stefano SANVITO, School of Physics, Trinity College (IE)

Start date: June 2009

End date: October 2014

Total budget: 841 452 €

- Project 170_ INANONAK

Abstract : Functional materials and devices at lengthscales of less than 1 micron are topics of profound scientific and technological interest, as they lie at the interface between 'bottom-up' construction and 'top-down' processing. Nano lengthscales become especially significant at cell surfaces where signalling across membranes is coupled to interfaces between macromolecular and supramolecular assemblies. Here we set out to develop new nanoscale devices that operate precisely at these levels, aiming to prepare functional materials with controllable size to interface with membrane bound proteins and from these to transduce signals of biomedical significance. Our system will interface with the α 1-Na/K ATPase, a novel oncology target if its activity can be controlled. Our synthetic nano-devices will target specifically a sub-set of α 1-Na/K ATPases, and will be engineered to assemble and interact at the local sites and lengthscales where the ATPase operates in a disease state.

Team :

Maria VICENT, Polymer Therapeutics Laboratory, Centro de Investigacion Principe Felipe (ES)

Cameron ALEXANDER, University of Nottingham (UK)

Stefano SALMASO, University of Padova (IT)
Tatjana MIJATOVIC, UNIBIOSCREEN SA (BE)
Start date: September 2009
End date: October 2012
Total budget: 649 632 €

- Project 150_MagNaSwimmers

Abstract : A key step in achieving interaction or exchange between nano-objects is the ability to bring them into spatial vicinity, e. g. by inducing directed individual or cooperative motion. We develop an approach making use of the interaction between asymmetrically decorated magnetic nanoparticles and an alternating magnetic field to induce translational movement of the nanoswimmers. While the propelling drive is mainly determined by the properties of the magnetic particle head and the magnetic field parameters, the conformation, helicity, and rigidity of the polymer chains that serve as flagella in the nano-object motion may be altered by e.g. ionic strength of the solvent (polyelectrolyte), temperature (LCST/UCST polymer) or pH (polyacid). Based on similar synthetic concepts, we expect to gain access to more sophisticated structures composed of these elementary units.

Team :

Annette SCHMIDT, Institut fuer Organische Chemie und Makromolekulare Chemie, Heinrich-Heine-Universitaet (DE)
Moshe GOTTLIEB, Chemical Engineering Dept. and Institute for Nanoscale Science & Tech., Ben Gurion Univ. (IL)
Ben FERINGA, Stratingh Institute for Chemistry, Rijksuniversiteit Groningen (NL)
Haim DIAMANT, School of Chemistry, Tel Aviv University (IL)

Start date: June 2009
End date: April 2013
Total budget: 786 325 €

- Project 044_NOIs

Abstract : We aim to use optical nanofibres for interfacing, manipulating, and controlling nanoparticles with light. Such nanofibres will be integrated into novel environments, including ion traps, cold atom traps, and optical tweezers. We will experimentally investigate the coupling of a single or few ions with the evanescent field of an optical nanofibre and explore the possibility to trap ions in the vicinity of the evanescent field. On the theory side, the collective coupling of ions or atoms trapped close to a nanofibre via evanescent fields will be modelled. Furthermore, using higher order optical modes, we aim to tailor the evanescent field and to study the optical binding of complex three dimensional arrays of colloidal particles in the vicinity of the nanofibre as well as their response to transfer of angular momentum. Finally, we will consider the feasibility of trapping neutral atoms in the evanescent field of a guided nanofibre mode exhibiting a complex polarisation pattern.

Team :

Sile NIC CHORMAIC, Tyndall National Institute, University College Cork, National University of Ireland Cork (IE)
Arno RAUSCHENBEUTEL, QUANTUM, Institute of Physics, University of Mainz (DE)
Philip JONES, Department of Physics and Astronomy, University College London (UK)
Rainer BLATT, Institut fuer Experimentalphysik, Universitaet Innsbruck (AT)
Vladimir MINOGIN, Laboratory for Laser Spectroscopy, Institute of Spectroscopy (RU)

Start date: June 2009
End date: June 2012
Total budget: 838 668 €

- Project 108_Nanopore

Abstract : The aim of this proposal is to use solid-state interfaced with biological nanopores to develop a novel force spectroscopy on the single molecule level. Nanopores offer a unique possibility for analysis of molecules in a volume of $\sim 10^{-23}$ l. Electric fields allow to pull charged macromolecules into and through the pore, while the ion current contains information about the molecule and its interaction with the channel surface. Here we use optical tweezers with ion current detection to apply forces and position a molecule in a pore. This leads to a novel, nanopore-based force spectroscopy enabling pN force detection while controlling the distance with nm resolution along a molecule in a biological nanopore. Our tool will be used to investigate the underlying physics of interaction, translocation or unfolding of macromolecules in pores. The current consortium will claim a worldwide lead position with this technique. Our proposed technology could lead to groundbreaking experiments.

Team :

Ulrich F. KEYSER, Cavendish Laboratory, University of Cambridge (UK)

Mathias WINTERHALTER, Biophysics/Jacobs University (DE)

Cees DEKKER, Kavli Institut of Nanoscience (NL)

Loic AUVRAY, Matériaux Polymères aux Interfaces, UMR7182 /Université Evry (FR)

Start date: June 2009

End date: June 2013

Total budget: 878 400 €

- Project 056_E2-Plas

Abstract : Carbon nanotube opto-electronics and plasmonics exploit novel fascinating physical phenomena and are among the most promising research areas for nanotechnology providing functional nano-objects for data transfer and processing at ultimate device densities. We propose interfacing these two technologies to create the first efficient electrically driven multiplexing surface plasmon source. In the first two steps, we explore the laws governing the near-field coupling between nanotubes and plasmon-guiding metallic nanostructures. Utilizing high-resolution optical microscopy we probe the electrical fields along single nanotube / metal waveguides visualizing both localized and propagating excitations. Finally, we use an electroluminescent nanotube to launch surface plasmons on demand in addressable waveguides. Our team is formed by peers in the field of plasmonics, near-field microscopy and carbon nanotube technology providing the expertise required to addressing this challenging project.

Team :

Alexandre BOUHELIER, Institut Carnot de Bourgogne CNRS UMR 5209 (FR)

Achim HARTSCHUH, Dep Chemie Und Biochemie, LMU München (DE)

Maria ALLEGRI, Dipartimento di Fisica, CNISM UdR Università di Pisa (IT)

Start date: June 2009

End date: September 2012

Total budget: 614 525 €

- Project 070_MEMORY

Abstract : The continuous demand for device miniaturization poses technological and economic barriers that cannot be answered by current fabrication techniques. This proposal is aimed at the development of a simple technique for the fabrication of crossbar electrode arrays for non-volatile memory devices based on a modulated block copolymer/nanoparticle (BCP/NP) assembly approach, where the ability to control the interfacial interactions between the NPs and the BCP domains under an electric field is crucial for obtaining the desired structure. Through a tight collaboration between experimental chemists, theoreticians, and an electrical engineer we intend to unravel the fundamental behavior of BCP/NP assembly under the influence of a directing electric field, and then to utilize the structures formed for the creation of an ultrahigh-density, multi-component memory device.

Team :

RoySHENHAR, Institute of Chemistry (IL)
Nir TESSLER, Faculty of Electrical Engineering (IL)
Alexander BOEKER, Physikalische Chemie II (DE)
Agur SEVINK, Leiden Institute of Chemistry (NL)
Andrei ZVELINDOVSKY, Centre for Materials Science (UK)

Start date: June 2009

End date: April 2013

Total budget: 1 097 250 €

- Project 072_ CUBI-HOLES

Abstract : We aim to grow specific-sized metal and semiconductor nanoparticles inside water-soluble rigid molecular cages called cucurbiturils, and subsequently assemble them into functional nano-chains. Combining these filled cages with well-defined connector molecules allows us to precisely define particle geometries, particle separations and particle interfacing. This in turn enables the robust construction of plasmonic optical antennae at visible wavelengths, room temperature single-electron-tunnelling transistors and combined photovoltaics. Such functional properties allow novel alternative methods for directed assembly using irradiation with precisely-tuned lasers, nano-electrochemistry or electric fields. This approach opens up a new platform Nanotechnology for organic-inorganic ordered nano-composites.

Team :

Jeremy BAUMBERG, NanoPhotonics Centre, University of Cambridge (UK)
Oren SCHERMAN, Melville Laboratory, University of Cambridge (UK)
Alexander KUHN, Institut for Molecular Science, University of Bordeaux 1 (FR)
Javier AIZPURUA, Center of Materials Physics, CSIC (ES)

Start date: October 2009

End date: September 2013

Total budget: 853 896 €

- Project 045_ Nanocommunication

Abstract : Eukaryotic viruses replicating in the nucleus must pass two barriers, the plasma membrane and the nuclear envelope, to deliver their genome to a compartment allowing replication, and to initiate an infection. Viral nanomachines have evolved to efficiently interface with and overcome these barriers. To arrive at a thorough understanding of this molecular interfacing we will address the following questions: i) What is the mechanochemistry of contact formation between an enveloped viral particle and a cell membrane? How does interfacing between a viral and a host membrane trigger capsid release in the cytosol? ii) What are the physical, structural and chemical principles underlying functional coupling between viral capsids and nuclear pore complexes allowing access to the nucleus? How is the release of the viral genome triggered? Dissecting and describing these molecular interfacing mechanisms will provide researchers with tools to design nano-objects that can enter and influence cells.

Team :

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Start date: June 2009

End date: June 2013

Total budget: 880 000 €

- Project 027_Mol-Machines

Abstract : We propose to develop a dynamic nanotool for use in drug discovery. This nanotool is based around a nanoactuator that uses a biological molecular motor to manipulate DNA and attached objects, in this case a magnetic bead. An electronic sensing system, based on MagnetoResistive (MR) devices will detect motion of the magnetic bead and output an electronic signal. Both the DNA and the motors can be targets for drugs, which means the device can be used in screening drug-target interactions. The major advantage this system offers is single molecule detection and reporting of events, which will improve sensitivity to limits that are possible. The concept will be expanded by making novel use of branched and hairpin structures to provide information about position of binding of DNA-binding proteins, which will allow us to identify drugs targeted at non-motor DNA-binding proteins such as transcription factors.

Team :

Keith FIRMAN IBBS, Biophysics Laboratories (UK)

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Start date: June 2009

End date: October 2012

Total budget: 757 000 €

- Project 202_NanoWave

Abstract :

The scientific objective is to develop an understanding of the phase coherency and the mechanism of phase locking in arrays of nano-contacts in the process of spin polarised induced generation of microwaves by spin torque. We shall focus on the microwave oscillator and its dependency on the size and separation between individual nanocontacts. The nanocontacts shall be formed by intersection of an array of magnetic nanowires and cross-electrodes. We shall investigate the effect of the coherent coupling of microwave emissions from such arrays and determine the power enhancement as a factor of proximity between the neighbouring nanowires or between magnetic contacts positioned along the same nanowire. Project innovations are the self-assembly of arrays of nanocontacts using a deposition technique capable of forming planar arrays of nanowires and the geometry of magnetic nanocontacts that allows for experiments with large angle between magnetic moments of the two ferromagnetic layers.

Team :

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Start date: September 2009

End date: September 2012

Total budget: 581 254 €

Once the Call has been launched, the main objective of NANOSCI-EPLUS was the administrative and financial follow-up of the transnational projects launched. Each national agency was in charge of following-up the national projects. The follow-up of the national contracts were performed within agencies following their usual practices and, from a coordination perspective, are remaining activities contained in "black boxes" that the consortium does not intend to survey or interfere with. Another objective was to extend the period of the project. Indeed, due to administrative matters, some transnational projects did not begin on time. Then, the final date of the projects has been delayed, and many projects will not end by the end of the ERA-NET Plus action. This is serious issue since part of the budgeted funds may actually be allocated after the end of NanoSci-E+ and therefore will not meet the regulatory requirements for being considered as eligible costs. This is

true in particular for those agencies that pay upon submission of receipts i.e. do not advance money to the grantees.

According to the DoW, the administrative management of research contracts has been decentralised. I.e. each agency carried out the administrative tasks for each of the TNPs that begun in 2009, 2010 and 2011, by following the projects. They also distributed the funding to the projects they were in charge of.

It was also planned, within WP3, to prepare the first mid-term review conference. The Conference was held in Dublin on 7-9th June 2011, and was aimed at carrying out the assessment of the projects progress towards their initial objectives, and a review of each project was made.

The objective of the Dublin conference on 7-9 June 2011 was to review progress at the mid-term point of the 24 projects funded in the NanoSci-E+ call 'Interfacing Functional Nano Objects'. Four independent panel members were asked to review the projects against the following criteria: what progress have the projects made towards their initial objectives? what has been the added value of joint European funding towards the achievement of their project goals? what are the major achievements and outcomes of the projects? Each of the projects was asked to bring up to 4 representatives from more than one country, including a new researcher. They were asked to present progress in the form of a presentation and a poster. The panel used these two inputs plus the original proposal forms to generate the following conclusions.

Overall, the panel were very impressed with the projects presented and thought that it was an excellent programme. One panel member in particular felt that many were encouragingly risky compared to standard EU funded projects. They were positive about the added value of these programmes in creating a critical mass inside of Europe. The additional funding which these projects provide for travel between the groups was seen as a real plus, particularly in strongly interdisciplinary projects. Clearly, some projects had capitalised on this opportunity more than others. They were happy about the numbers of postdoctoral researchers and PhD students being trained through this initiative. Many of the projects had struggled to recruit good postdoctoral researchers but the panel were clear that this was not an issue exclusive to the nanoscience area. However, due to budget restrictions, it has not been possible to organize another Conference for the final results of the transnational projects.

The final scientific results of this Call will be known after the end of the NanoSci-E+ project. As the funding for most of the transnational projects begun late, some funding will end after the end of the project. That is why the final report for each consortium will be sent in April 2013, for a final result at that period.

Potential impact

The potential impact of this project has to result from the questionnaire and deliverable 3.4 "Report on call impact and recommendations for future actions". The results of the questionnaire have been delayed, some funded projects finishing after December 31st 2012.

Overall, the general impact is the generation of added-value in the European nanoscience cooperation through increasing the knowledge of partners about each other's programmes and activities as well as enhancing the cooperation and coordination among such programmes and activities. With the achieved critical mass, coordination activities of NanoSci-E+ have reinforced the impact of nanoscience cooperation at national, regional and European levels.