EUROPEAN SCIENCE FOUNDATION

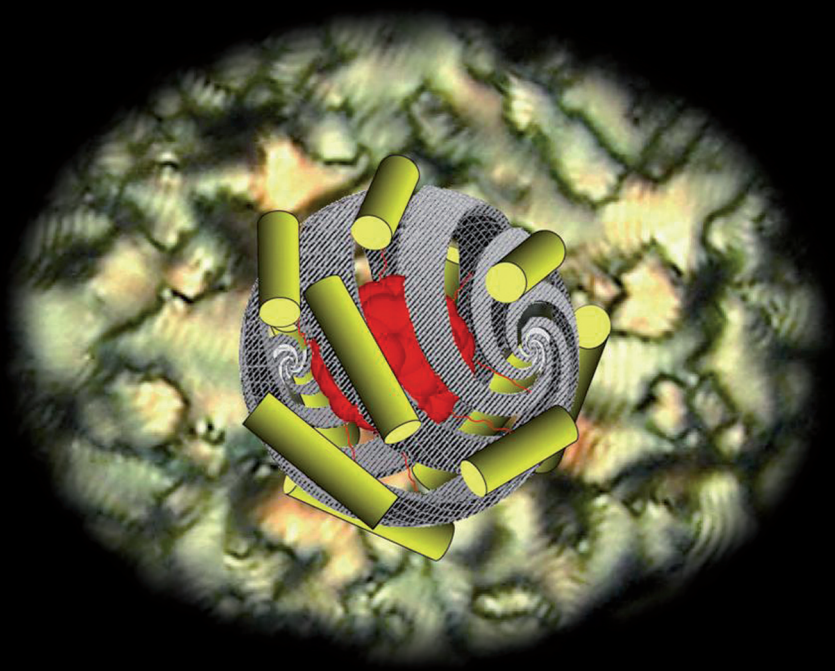
SETTING SCIENCE AGENDAS FOR EUROPE

EUROCORES Programme

European Collaborative Research

SONS II

Self-Organized NanoStructures



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Self-organisation, or self-assembly, is a process in which a supramolecular organisation is established in a complex system of interlocking components. The mechanism that produces the organisation is determined by the competing interactions between the components. The hierarchy of interactions determines the hierarchy of levels in the final nanostructured material. Thus, self-organising compounds allow a defined and well-controlled construction of ordered architectures on a nanometer-scale.

The SONS Programme concerns the utilisation of supramolecular interactions to synthesise and position functional assemblies, macromolecules, dendrimers, liquid crystals, tailor-made polymers and inorganic nanoparticles.

Molecular self-assembled architectures may find applications in advanced technologies such as new chip technologies (DNA probes, lab-on-the-chip), sensors, transistors, light-emitting diodes, communication technologies, magnetic information storage, photovoltaic cells, and molecular motors and machines.

The second Call for Proposals of SONS was launched in May 2005, and seven Collaborative Research Projects (CRPs) were selected for funding, bringing together 51 research groups from 15 countries, with a total budget of almost 8 Mio Euros.

The SONS Programme fosters pan-European collaborative research, networking and training as well as dissemination of scientific results and activities developed in the frame of this programme.

List of funded Collaborative Research Projects (CRPs)

SUPRAmolecular MATerials for new functional StructurES (SUPRAMATES)

(CNR, DFG, EPSRC, FWO)

SUPRAMATES is a Collaborative Research Project focused on the use of π-conjugated supramolecular nanostructured materials as active building blocks for the development of multiscale prototypes of optoelectronic devices, including FETs, OLEDs and solar cells.

Project Leader:

Dr. Paolo Samorì
Istituto per la Sintesi Organica e la Fotoreattività (ISOF), Consiglio Nazionale delle Ricerche (CNR), Bologna, Italy

Principal Investigators:

Dr. Franco Cacialli
University College London, London Centre for Nanotechnology, London, United Kingdom

Professor Richard H. Friend
University of Cambridge, Cambridge, United Kingdom

Dr. Johan Hofkens
University of Leuven, Heverlee, Belgium

Professor Klaus Müllen
Max-Planck-Institute for Polymer Research, Mainz, Germany

Associated Partner:

Professor Alan Edward Rowan
University of Nijmegen, Nijmegen, Netherlands

Assembly and Manipulation of Functional Supramolecular Nanostructures at Surfaces (FunSMARTs II)

(DFG, SNF, CSIC, CNR)

FunSMARTs II is engaged in the structural realisation of nanostructured functional molecular systems by hierarchical self-assembly processes.

By concentrating on the functionality "Molecular Magnetism" in two different variations (long-range ordered 2D domains and 0D single molecule magnets), this project expects to carry out "proof–of-principle" experiments on how to integrate and to manipulate molecular magnetic domains within demonstration operable devices.

Project Leader:

Dr. Mario Ruben
Institute of Nanotechnology, Research Centre Karlsruhe, Karlsruhe, Germany

Principal Investigators:

Professor Johannes V. Barth
Physik Department, TU München, Garching, Germany

Dr. Fabio Biscarini
Istituto per lo Studio dei Materiali Nanostrutturati (ISMN), Consiglio Nazionale delle Ricerche (CNR), Bologna, Italy

Professor Harald Brune
Institute of the Physics of Nanostructures (IPN), EPFL, Lausanne, Switzerland

Professor Alessandro De Vita
Department of Materials Engineering and Applied Chemistry, Consiglio Nazionale delle Ricerche (CNR), Trieste, Italy

Professor Klaus Kern
Institute für Festkörperforschung, Max-Planck-Gesellschaft, Stuttgart, Germany

Dr. Nian Lin
Institute of Solid State Research Stuttgart, Max-Planck-Gesellschaft, Stuttgart, Germany

Professor Jaume Veciana Miró
Institut de Ciencia de Materials de Barcelona, CSIC, Cerdanyola del Valles, Spain

Associated Partners:

Professor Flemming Besenbacher
Institute of Physics & Astronomy, University of Aarhus, Interdisciplinary Nanoscience Center (iNANO), Aarhus, Denmark

Professor Bjørk Hammer
Institute of Physics and Astronomy, Aarhus University Interdisciplinary Nanoscience Center (iNANO), Aarhus, Denmark

Self-Organised Hybrid Devices (SOHYD)

(FWO, EPSRC, SNF, CSIC, DFG)

This project is focused on designing new nanoscale assemblies using inorganic and organic building blocks combined into (block) co-polymers and hybrid structures. The functional units in these co-polymers are chosen for their opto-electronic properties such as light absorption, electronic charge transport, exciton formation or charge separation and light emission. Using physical adhesion to molecularly engineered surfaces and by the inherent property of block co-polymers to form (nano) separated phases, self assembled well-defined nanoscopic architectures will be prepared. These structures will be evaluated using electron and optical spectroscopic techniques such as, impedance spectroscopy, laser transient spectroscopy, steady state and lifetime emission measurements, either as is, or integrated in simple model devices.

Project Leader:

Professor Dirk Vanderzande
University of Hasselt, Institute for Material Research (IMO), Diepenbeek, Belgium

Principal Investigators:

Professor Juan Bisquert Mascarell
Universitat Jaume I, Castelló, Spain

Professor Eugenio Coronado Miralles
Instituto de Ciencia Molecular (ICMol), Universidad de Valencia, Burjassot, Spain

Professor Michael Grätzel
Institut des sciences et ingénierie chimiques, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Dr. Saif Haque
Imperial College London, London, United Kingdom

Professor Nazario Martin
Facultad de Química, Universidad Complutense de Madrid, Madrid, Spain

Dr. Mukundan Thelakkat
University of Bayreuth, Bayreuth, Germany

Professor Tomas Torres-Cebada
Facultad de Ciencias, Universidad Autonoma de Madrid, Madrid, Spain

Liquid Crystals Nano-particles (LC-NANOP)

(EPSRC, DFG, PAN)

In this project an innovative approach towards combining the newly established field of nano-structuring with that of liquid crystals is proposed through the synthesis, analysis, characterisation and physico-chemical studies of liquid crystal mesogenic materials bound to central scaffolds of various chemical types, in order to give liquid crystal nanoparticles. In contrast to existing materials, nanostructured LCs can combine self-organisation with the ability to form secondary and tertiary structures, in a structural hierarchy similar to that found for proteins. Furthermore, super and supra-molecular LCs can exhibit a variety of physical properties which make them attractive for applications in the fields of nanoscience, materials and biology. The final goal of this CRP is to utilise the unique self-organising abilities of LCs in a bottom-up approach to the creation of ordered arrays of nanoparticles, rather than the currently used, but self-limiting, top-down methodologies. In taking this approach, liquid-crystalline nanoparticles with hierarchical hybrid structures with specific built-in functionality will be prepared.

Project Leader:

Professor John Goodby
Faculty of Science, University of York, United Kingdom

Principal Investigators:

Professor Ewa Gorecka
Faculty of Science, University of Warsaw, Warsaw, Poland

Professor Heinz Kitzerow
Faculty of Science, University of Paderborn, Paderborn, Germany

Associated Partners:

Dr. Daniel Guillon
Institut de Physique et Chimie des Matériaux, Université Louis Pasteur, Strasbourg, France

Professor José Serrano
Facultad de Ciencias, Universidad de Zaragoza, CSIC, Zaragoza, Spain

Complexity Across Lengthscales in Soft Matter (SCALES)

(EPSRC, DFG, PAN)

This project will focus in particular on novel highly complex structures formed by liquid crystals and star block copolymers consisting of 3 and 4 incompatible types of moieties. The recently introduced honeycomb columnar LC phases in ternary amphiphiles are rapidly expanding in diversity and complexity and, while they will be developed further, several series of quaternary amphiphilic compounds will be synthesised and studied with a view of creating complex 3D structures. The new structures will also be doped with guest species such as metal ions and functional molecules to investigate their further application potential. A novel approach to creating order on colloidal length scale using liquid crystal medium will also be applied. The general aim is a unified approach to soft matter organisation from nanometer to micrometer.

Project Leader:

Professor Goran Ungar
University of Sheffield, Sheffield, United Kingdom

Principal Investigators:

Professor Volker Abetz
Institute of Chemistry, GKSS Research Centre Geesthacht GmbH, Geesthacht, Germany

Dr. Martin Bates
University of York, York, United Kingdom

Professor Robert Holyst
Institute of Physical Chemistry, Polish Academy of Sciences, Warsaw, Poland

Professor Carsten Tschierske
Institute of Organic Chemistry, University of Halle, Halle, Germany

Associated Partner:

Professor Janez Dolinšek
Josef Stefan Institute, Ljubljana, Slovenia

Self-Assembled Nanoscale Magnetic Networks (SANMAG)

(CNR, DFG, SNF, FWF)

The project aims at exploiting self-assembly processes for creating and developing bottom-up architectures of planar magnetic networks constituted by sub-nanometer size functional elements. Elemental and alloyed nanomagnets of controlled size organised into regular patterns offer new perspectives for exciting developments in the timely fields of nanoelectronics, spintronics, and quantum computation. The proposed collaborative project will develop self-assembly strategies to design nanomagnetic networks by controlling the specific properties of individual atomic-scale magnets, their mutual interactions, and coupling with the environment.

Project Leader:

Dr. Carlo Carbone
Consiglio Nazionale delle Ricerche, Istituto di Struttura della Materia, Area Science Park, Basovizza-Trieste, Italy

Principal Investigators:

Professor Stefan Blügel
Institut für Festkörperforschung, Forschungszentrum Jülich, Jülich, Germany

Professor Harald Brune
Institute of the Physics of Nanostructures (IPN), EPFL, Lausanne, Switzerland

Professor Klaus Kern
Institute für Festkörperforschung, Max-Planck-Gesellschaft, Stuttgart, Germany

Professor Peter Varga
Institut für Allgemeine Physik, Technische Universität Wien, Wien, Austria

Associated Partner:

Dr. Pietro Gambardella
Institut Català de Nanotecnologia, Centro mixto CSIC-UAB, Barcelona, Spain

Biofunctional Self-organized Nano-Structures of Ionic/Non-Ionic Amphiphilic Copolymers, Biopolymers-Biomacromolecules and Nanoparticles: From Bioinspired to biointegrated systems (BIOSONS)

(SNF, DFG, GAČR)

BIOSONS aims to develop a new generation of self-assembling materials by coupling biological functions (by selected peptides and oligo-nucleotides, natural proteins and biological complex materials) to synthetic polymers as a way to boost their (bio)functionality.
By this truly multidisciplinary approach and with the decisive incorporation of sophisticated biological resources, much more complex, well defined and (bio)functional materials will be (bio)produced and manipulated to achieve a new standard in the self-assembling capabilities and functionalities of self-assembling macromolecules. Breakthrough soft and hard SONS, in terms of structure and function, are expected to be obtained in BIOSONS as well as new background of theoretical and methodological concepts in self-assembling material science and engineering.

Project Leader:

Professor Wolfgang Meier
University of Basel, Basel, Switzerland

Principal Investigators:

Professor Matthias Ballauff
Universität Bayreuth, Bayreuth, Germany

Professor Axel Mueller
University Bayreuth, Bayreuth, Germany

Dr. Helmut Schlaad
Max Planck Institute of Colloids and Interfaces (MPI-KGF), Golm, Germany

Dr. Petr Stepanek
Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Associated Partners:

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Université de Pau et des Pays de l'Adour, CNRS & University of Pau, Pau, France

Dr. Günter Reiter
Institut de Chimie des Surfaces et Interfaces, Mulhouse, France

Professor José Rodríguez-Cabello
E.T.S.I.I., University of Valladolid, Valladolid, Spain

Cooperating Partner:

Professor Frédéric Nallet
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The aim of the European Collaborative Research (EUROCORES) Scheme is to enable researchers in different European countries to develop collaboration and scientific synergy in areas where European scale and scope are required to reach the critical mass necessary for top class science in a global context.
The scheme provides a flexible framework which allows national basic research funding and performing organisations to join forces to support excellent European research in and across all scientific areas.
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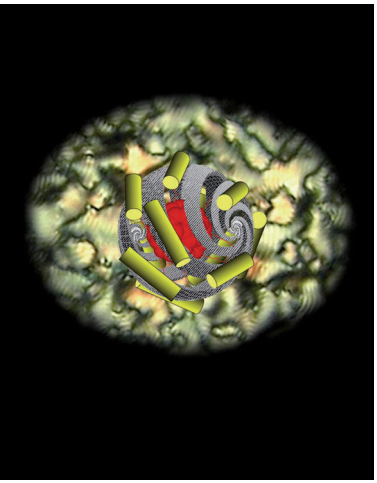
THE FOLLOWING NATIONAL FUNDING ORGANISATIONS SUPPORT THE SONS 2 PROGRAMME:

- Fonds zur Förderung der wissenschaftlichen Forschung in Österreich (FWF)
  Austrian Science Research Fund, Austria
- Fonds voor Wetenschappelijk Onderzoek - Vlaanderen (FWO)
  Fund for Scientific Research – Flanders, Belgium
- Grantová agentura České republiky (GAČR)
  Czech Science Foundation, Czech Republic
- Deutsche Forschungsgemeinschaft (DFG)
  German Research Foundation, Germany
- Consiglio Nazionale delle Ricerche (CNR)
  National Research Council, Italy
- Polska Akademia Nauk (PAN)
  Polish Academy of Sciences, Poland
- Consejo Superior de Investigaciones Científicas (CSIC)
  Council for Scientific Research, Spain
- Schweizerischer Nationalfonds (SNF)
  Swiss National Science Foundation, Switzerland
- Engineering and Physical Sciences Research Council (EPSRC), United Kingdom

SONS II Programme



A molecular 'Boojum' - a chiral liquid crystalline nanoparticle. The chemical structure design is shown above the liquid crystal texture of the chiral nematic phase. Profs. John W. Goodby and Isabel M. Saez, University of York, UK (LC-NANOP Project)

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