European Cooperation
in Science and Technology
- COST -

Secretariat

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COST 4181/11

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action MP1106: Smart and green interfaces - from single bubbles and drops to industrial, environmental and biomedical applications (SGI)

Delegations will find attached the Memorandum of Understanding for COST Action as approved by the COST Committee of Senior Officials (CSO) at its 183rd meeting on 30 November 2011.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action MP1106
SMART AND GREEN INTERFACES: FROM SINGLE BUBBLES/DROPS TO INDUSTRIAL/ENVIRONMENTAL/BIOMEDICAL APPLICATIONS (SGI)

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to organize a European interdisciplinary cooperation platform directed towards scientific added value and improvement of industrial, environmental and medical applications concerning interfaces, bubbles and drops.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 80 million in 2011 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Bubbles and drops are entities of enormous practical interest since their interfaces are met in numerous industrial processes and applications of every day life. In order to enhance efficiency, the creation of revolutionary Smart interfaces is demanded: interfaces that are easily manipulated with well-controlled size and properties. The acute modern environmental problems require attributing eco-friendly features to Smart interfaces by incorporating innovative materials or processes. The outcome is Smart and Green (S&G) interfaces. The objective of this Action is to organize a network of groups from academia and industry in order to identify best strategies and means to produce S&G interfaces. Furthermore, state-of-the-art experimental, theoretical and numerical work will be combined to acquire insight into the underlying phenomena *through the scales* and *across the disciplines* for the implementation of S&G interfaces in industrial, environmental and biomedical applications. The Action's main deliverables are the networking between groups working on different aspects of S&G interfaces through organization of scientific events, training schools and STSMs, and the industrial interface to market new technologies. The professional perspectives of ESRs will be boosted through an extensive mobility program. The Action's main benefit is the endorsement of the European scientific and industrial leadership in this field.
Keywords: interfaces, bubbles, drops, surface agents, wetting

B. BACKGROUND

B.1 General background

Real current problems/scientific issues:

Bubble and drop (B&D) interfaces are fundamental to numerous industrial, environmental and biomedical applications. Smart and Green (S&G) interfaces are tailored B&D interfaces that can accomplish a technological task with high efficiency, adaptability and selectivity, while being also eco-friendly (biodegradable, reusable or simply more durable). The means to tailor S&G interfaces and accurately control their performance span from synthesis of novel materials to manufacturing processes and advanced diagnostics. The advances in Colloid Science, in Material Science and Chemistry, in Process Engineering, in Physics of droplets and bubbles and in Environmental

Engineering have been significant during the last decades but there is a gap in the communication between people working in these areas that reduce the efficiency of real-life applications relevant to these subjects. In this view, the tasks of this Action are not horizontal subdomains of a scientific discipline but establish communication links through several scientific and engineering disciplines in order to improve the diverse interfaces-mediated applications.

Wide Relevance:

The industrial, environmental and biomedical applications involving B&D interfaces (such as detergents, food foams and emulsions, cosmetics and paints, boilers/condensers, distillation and flotation columns, crude oil transportation, drug encapsulation, controlled drug delivery etc) are of high relevance for the European society. Unfortunately, research groups involved in this field typically lack cooperation with industrial developers and end-users, which would drive and exploit more effectively the research activities. To address such a need for cooperation of research groups (both among themselves and with the industrial sector), this Action is intended at gathering the most active European research institutes and companies in the field and also some non European institutions.

Why COST?:

Research activities in this field today are fragmented into several groups, which are largely disjoint. Fragmentation is both at European and global scale. These groups typically work on different types of materials, processes and diagnostics, while, at the same time, they have to address fundamental issues that are common to all of them, so that they usually have to deal with analogous scientific and technical challenges. The absence of any integrated approach to the problems appears to be detrimental to the achievement of major breakthroughs. A COST Action is the ideal mechanism for developing a more integrated and collaborative program, since this field requires the networking of international researchers and practitioners from a disparate range of disciplines. The COST funding scheme will boost the resolution of critical scientific problems especially those through the scales and across the disciplines.

Benefits from COST framework:

COST scheme allows setting up a network through different scientific domains or disciplines (like colloid science, interface science or environmental engineering) to a really interdisciplinary approach. This is not possible with other regular research funding schemes which are chiefly targeted to specific domains. So, COST Action will bring cross-infusion of knowledge and expertise and on one hand will lead to significant scientific and technological achievements and on the other will scale up the benefits for the European industry and strengthen the international competitive ability of EU.

B.2 Current state of knowledge

Previous research in the field:

Interfaces, in the generalized notion tackled in the present Action, constitutes an interdisciplinary and multiscale subject spanning from fundamental to applied sciences and from molecular to macroscopic size scales. Parallel to the theoretical development of fundamental issues of Colloid and Interface Science by well-known physicists and chemists at the first half of the 20^{th} century, the practical use of systems containing interfaces like emulsions, foams and sols was constantly expanding based on empirical rules without rigid scientific foundation. Regarding sols, the convergence of technological practice to fundamental scientific principles came along with a specific event: the development of DLVO theory that explains sols stability based on first principles. The corresponding development for the case of emulsions and foams did not proceed by an equally huge step like the DLVO theory but followed an advancement in small steps, like the hydrophilic-lipophilic balance (HLB) in the case of emulsions. Literature on these classical subjects that attempts to relate applications with scientific foundation in order to extent the fundamental knowledge and to improve the applications is extensive today. In parallel, new technological issues appear (such as smart or biomimetic interfaces) that call for fundamental backing and technologies to control them. One of the reasons for the rich literature during the last decade on analyzing applications based on first principles is the vast increase in computational power and the development of sophisticated numerical methods.

These tools render possible quantitative analysis that was not accessible before. Further to the above interface-centered issues there are many applications from the medical (diagnosis, controlled drug release), energy (boiling, evaporation), industrial (flotation, extraction) domains that use interfaces as a device to achieve certain goals. Unfortunately, the advancement of the individual fields related to the present Action has not been concerted so there is a need for integration of efforts and for developing a common language between the scientists of the different fields which will allow cross-fertilization and exchange of knowledge and expertise to improve applications and provide firm scientific support for them.

Relevant research within the EU:

Recently, *nanoscience* and *nanotechnology* have been identified as the objectives of priority areas of EU Framework programs, ERA-NET calls and national programs. These objectives cover different aspects such as composing new materials for applications, energy producing and saving technologies, environmental protection and restoration, health care, etc. All these areas have direct relevance to B&D interfaces as the latter represent efficient means for controlled mass and heat transport across immiscible phases. The scientific and industrial literature is flooded with information which deals either with interfaces at the scale of single B&D entities or with large scale applications. Recently, there have been systematic attempts to bridge micro-scale with macro-scale phenomena. The relevant research within EU has been clearly depicted in the COST Action P21: Physics of Droplets which was recently completed successfully and which created a new core interdisciplinary scientific community of highly qualified partners. The present Action can be seen as a continuation of that Action aiming at a broader scientific community and incorporating for the first time so many key industrial stakeholders in the field.

Innovation:

As a fundamental innovation, this Action intends to address scientific needs of documented primary relevance (reported in section D.1), by hierarchical research through multiple length scales and across diverse disciplines. The scientific and technical activities will be performed by leading research institutions and industrial stakeholders, which will co-operate for the first time within a network unique at global level. As a further feature of this COST Action, the research institutes will cooperate with two types of industrial partners: technology developers (for industrialization) and technology end-users (for specific applications).

In particular, the end-users will define requirements for each specific application, so that the research institutes will tailor the scientific developments according to clear industrial needs; the industrial developers will implement all those technological improvements and optimizations that are typically required, in general, to transform a laboratory demonstrator into a product that is reliable and can be industrialized. The products will be integrated by the end-users into systems for specific applications. This scheme, whose implementation is detailed in section D, will permit to cover the full chain, from basic research, up to product development and commercial exploitation.

B.3 Reasons for the Action

Need for an experts network, added value, benefits:

Developing Smart & Green interfaces requires major scientific and technological advances (anticipated in section B.1 and detailed in section D), that need considerable interaction and cooperation (as reported in sections B.1 and B.2). Europe hosts several research institutes with a well consolidated and recognized expertise in the field of soft compliant interfaces and in particular on Bubble & Drop interfaces. Actually, much of the early stage research/breakthroughs have been pioneered by European research groups and still at present a lot of competence is centered and led by a number of groups in Europe. These groups have progressively adhered to a growing initiative to establish the Bubble & Drop network, which organizes biennially a widely recognized international conference (last B&D Conference in Thessaloniki, GR, 2009). The support of the cooperation among these highly qualified European experts, as well as between them and companies relevant to this field will offer a unique framework in order to achieve the desired fundamental improvements.

Within this context, the present COST Action will represent, at global level, the first example of an organically structured scientific network in the Smart & Green interfaces field, able to strengthen the impact of European science and technology. The Action will serve as a vital means to overcome the fragmentation of the field and the lack of resources for tackling major research issues in the field, as well as in its application domains. European research projects currently underway deal with topics that are only partially relevant to this Action, as reported in section B.4.

In particular, as none of them is aimed at addressing the fundamental scientific and technological needs mentioned in section B.1, the major goal of this Action is represented by the first coordination of research efforts aimed at solving those problems. Without any collaboration oriented to such a goal, the European research in the field will likely soon fall behind that in North America and Asia, where massive R&D programmes are progressively growing. Focusing and organizing research activities in this sector would provide Europe with a primary role not only in the scientific and technological growth of the field but also, at the same time, in the share of the related emerging market (see sections B.2 and D). The scientific, social and industrial benefits of the Action are described more extensively in section C.4.

Research objectives, means and application. Impact and outcomes of the Action:

This Action is principally aimed at European scientific and technological advance. Its focus will be on the development of Smart & Green interfaces and related processing to implement them to actual applications as mentioned in section B.1. The means that will be used to reach the scientific and technological goals are detailed in section D. Section D also describes the fields of application that will be studied primarily by the industrial partners of this network. These fields span several industrial sectors, including detergents, paints, foods, coatings, cosmetics, energy production (boilers/condensers), medical diagnostics, etc. Accordingly, this Action will have a large impact also for societal needs by training young researchers for careers in high level science and R&D management. While section C.4 describes the social and industrial benefits of the Action, its measurable outcomes, represented by its deliverables, are outlined in section C.2 and described in section D.2.

B.4 Complementarity with other research programmes

There are not many aspects of Smart and Green interfaces that benefit directly from current EU support although there are a few such projects funded by ESA (outside the FP7-Space Call) and by national programs and industry. There is some limited complementarily with FP7 projects in the "Nanosciences, nanothechnologies, materials and new production technologies" thematic area.

For instance, the FP7 projects “Multi-scale modelling of nano-structured polymeric materials: from chemistry to materials performance” (NANOMODEL), “Nanoengineered Nanoparticles and Quantum Dots for Sensor and Machinery Applications” (NANOSENSOMACH) and “Enhanced Nano-fluid Heat Exchange” (NanoHex) are dedicated to manipulating matter at the nanoscale to develop new technologies, products and processes. Smart interfaces are dealt with these activities inasmuch as bubbles and drops covered by surfactants, polymers and nanoparticles are used as controlling mass transfer devices. However, the Green aspect is missing. Contrary to this COST Action, the above programs are more focused on specific systems and applications. Currently, no Action exists bringing together the study of fundamental topics in Smart and Green interfaces comparable with this network . The COST Action CM1101: Colloidal Aspects of Nanoscience for Innovative Processes and Materials is complementary with the present Action as it focuses on materials that can be surface active and so can be used to modify the properties of interfaces. However, emphasis is on the colloids chemistry and nanoscale phenomena. Despite this, measures will be taken to avoid overlap with its activities.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The aim of the Action is to organize a Europe-wide interdisciplinary cooperation platform directed towards scientific added value and improvement of industrial, environmental and medical applications concerning interfaces, bubbles and drops.

C.2 Secondary objectives

The main objective of this Action is to organize a network of groups experienced in manufacturing, advanced characterization and modeling of interfaces in order to identify and implement best strategies and means to produce Smart and Green interfaces by coordinating human and facility resources. The goal is to ensure European scientific and industrial leadership in this field by building a platform of high level knowledge. The secondary objectives are defined by the scope of the research activities and the objectives of the four Working Groups of the Action (sections D, E):

1. Improvement of the fundamental understanding of the general interface structure and evolution dynamics. This will be achieved by a combination of theoretical development, the implementation of novel numerical techniques for solution of the governing equations and the exploitation of novel experimental techniques concerning both single and multiple interfaces.
2. Development of new materials relevant to creation of Smart and Green interfaces. These materials cover the whole span of size range and it can be surfactants, macromolecules, structured solid surfaces, solid foams, aerosol particles.
3. Development of novel and improvement of existing diagnostic techniques employing knowledge emerged from the first two objectives. The term diagnostics refers to the identification of the properties of the interfaces and to general real/life applications (e.g. medical diagnosis) in which interfaces/bubbles/drops intervenes.
4. Development or improvement of marketed industrial technologies and end user applications relevant to interfaces, bubbles and drops. The objective covers from consumer products to classical industrial processes and to computational tools for their design and optimization.

The evaluation of how well the Action can achieve its goals is best quantified through the tangible deliverables of this Action which are: (a) new eco-friendly materials or processes that will increase the efficiency, selectivity and adaptability of interfaces, (b) innovative industrial methods for producing and dispersing B&D of well-controlled size, population and stability, (c) pioneering instrumentation and diagnostic systems, (d) performance enhancement of multiphase industrial processes. Industry, instrumentation developers, medical device manufacturers, but also the wider population, are identified as end-users.

C.3 How will the objectives be achieved?

The means to achieve the aforementioned objectives is by exploitation of the knowledge and expertise gained by hierarchical research through multiple length scales and across diverse disciplines. This will be achieved via the coordinated activity of the large number of groups involved in this Action. The groups which are directly involved in this Action as well as those which will be involved once the Action is launched possess already much valuable expertise, manpower and all the required equipment for achieving the main and the secondary objectives.

Organization, support and dissemination of the scientific activities of the network:

The following means will be extensively adopted:

a) annual meetings of the partners in Working Groups to address the scientific and technological tasks reported in section D.

b) promotion, organization and support of collaborations between the research institutes and companies. The latter will consist of both industrial developers of materials/devices, as well as end-users of the technologies (see details in section D.2).

c) coordination and support of joint research efforts (especially research projects within the EU FP);

d) designation of “user-labs” with unique and expensive facilities.

e) designation of scientific Competence Centers for specific topics.

f) sharing of instrumentation and exchanging test samples among partners.

g) Short-term scientific missions: at least 70% of them for ESRs and at least 30% between academic institutions and industry.

h) specific training and support to ESRs, by means of:

- scientific missions of young researchers to institutes belonging to the Action (preferably) or not (if specific skills are needed);

- short-term exchanges of young researchers (Ph-D students and post-doc fellows) among partners;
- dissemination, promotion and support of specific opportunities for early-stage scientists (e.g. Ph-D and post-doc open positions, calls for grants, awards, etc.);
- support of active role in the network (e.g. organization of seminars).

i) periodical training schools and open workshops.

j) continuous update of Action website, serving both as a means of dissemination of data along with general information, through online documents, links, references, etc.

k) diffusion of information and scientific/technical results through several means of communication, such as joint papers, newsletters, etc.

Collaboration with industry: strong asset of this Action

Within the initial core groups interested in participating to this Action, there are 10 of the most important industries worldwide working on interfaces and their applications. The industrial partners consist of both primary technology developers and end-users of products. As a whole, they correspond to about 34% of the overall team at the time of writing this document. The number of industrial partners may increase during the duration of this COST Action as more end-users have been invited. Special efforts will be made to keep the industrial involvement active, by e.g., STSMs between academia and industries, participation in test campaigns and workshops, as a requirement essential to the applicability and exploitability of the scientific results.

4 Benefits of the Action

The benefits of this Action are multilateral. Regarding SCIENCE, the combination of physics and materials science with sophisticated diagnostic methods will advance the frontier of knowledge. Regarding INDUSTRY, the complementary work of groups will contribute to the development of new industrial applications regarding synthesis and processing of S&G interfaces that will improve efficiency and decrease energy consumption and so reinforce the competitiveness of European industry. SOCIETAL benefits are extrapolated from the enhanced performance and cheaper industrial products (detergents, foods, pharmaceuticals etc), to integration, training and personal development of Early Stage Researchers (ESRs). This project will bring in ENVIRONMENTAL benefits, through the development of Green materials, manufacturing processes and end-user technologies. Significant impact is expected in (a) increasing the scientific knowledge beyond the current state-of-the-art and creating high level ESRs (b) promoting collaboration between academia and industry and (c) setting consortium of partners aiming at submitting European proposals on forthcoming research projects e.g. FP7, RTN-Marie-Curie, etc.

C.5 Target groups/end users

There are several target groups in the Action: (a) the academic sector will enhance its research profile and will find new routes for research activities and collaborations, (b) the industrial partners will have direct access to new technologies that can be transferred to production lines, establish links with highly qualified research labs and have the chance to employ young scientists with experience in the field, (c) the ESRs will further their research careers and employment opportunities in generic and novel technologies and in industry, (d) the general public will have access to the dedicated web site of the Action displaying its activities as well as the long term implications and consequences of its research concerning industrial, environmental and medical applications. Quite a few academic as well as industrial partners have been involved in the preparation of this proposal in order to create a smooth interface among target groups.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The present Action attempts to mingle the European expertise on understanding, creating and handling gas/liquid/solid interfaces in order to design a new generation of interfaces presenting high efficiency while minimizing environmental impacts. These are Smart and Green (S&G) interfaces. The novelty in this Action is that it is not restricted to a particular scientific field but it exploits knowledge and expertise across diverse scientific disciplines and through multiple length scales in order to bridge different views and scientific languages. The Action includes four main topics corresponding to four individual Working Groups. These topics do not represent sub-areas of a scientific field but different ways/views of looking at the subject and different domains for technological exploitation of the Action results. The Working Groups represent four horizontal (H) levels across scientific disciplines: WG1: Fundamentals (H1), WG2: Materials (H2), WG3: Diagnostics (H3) and WG4: Technology (H4). WG1 is related to fundamental (theoretical and experimental) aspects of interfaces, WG2 to materials synthesis and characterization, WG3 to development and upgrade of diagnostic techniques and WG4 to improvement of technological/industrial applications. The general structure of the work-plan is a matrix of HORIZONTAL and VERTICAL levels as it is shown in Table 1. WGs reflect the classification in horizontal levels whereas within each WG the vertical (V) levels are represented by three length scales: (V1): micro-scale, (V2): meso-scale, and (V3): large-scale. The Green (eco-friendly) aspect runs through all the WGs. The work plan constitutes a very flexible and open framework which will enable new groups to join and integrate into the project in the future.

Table 1. Structure of the programme with designated Horizontal (H) and Vertical (V) levels

Project structure	Fundamentals (H1)	Materials (H2)	Diagnostics (H3)	Technology (H4)
Small scale (V1)	WG1	WG2	WG3	WG4
Mesoscale (V2)				
Large scale applications (V3)				
	Green Aspects consideration			

D.2 Scientific work plan methods and means

The scientific work plan for each WG, including methods and means, is as follows.

WG1. Fundamentals

The scope of this Working Group is to extend the current fundamental understanding of interface-related phenomena and to integrate/unify approaches across disciplines (from physics of fluids to physical chemistry and beyond) in order to improve the quantitative description of complex processes. To achieve this, a combination of theoretical developments, of model experiments and of numerical solution techniques is needed. The analysis in this WG can be divided in three length scales: (V1) one concerning single interfaces (e.g. an isolated bubble or droplet), (V2) one that concerns multiple interfaces (e.g. multi-bubble/droplet systems like clusters, aggregates or clouds) and (V3) one concerning combination of multiple interfaces at industrial scale (e.g. foams, emulsions) including also the effects of the container wall, external fields and surroundings.

The influence of surface properties (addition of surfactants, modified substrates) on the fundamental behavior (hydrodynamics and heat/mass transfer) of single bubbles and drops will be analyzed. Theories for bubble formation and growth and bubble motion in external fields (e.g., electrical, magnetic, temperature fields), will be extended based on new experimental data. New computational techniques (e.g. capturing the shape evolution of an interface based on the superposition of fundamental solutions of the fluid dynamics equation) and analytical approximations will be employed. Also, systems further to those typically treated in colloid and interface science like the high energy impact of jet droplets on modified surfaces will be theoretically and experimentally examined. The most important issue being the holy grail of the interface science is the quantitative relation of the intrinsic properties of interfaces (dynamic and static surface tension, rheological properties, microgeometry of solid surfaces, electric potential etc) to the macroscopic performance of complex interface systems (e.g. emulsion and foam stability, inception of boiling, spreading of paints). A sound advancement in this direction will be pursued by combined theoretical, experimental and numerical efforts employing scientists from the chemistry, physics and engineering disciplines.

WG2 Materials

This Working Group contains all the efforts for the development and tailoring of new materials meant for Green and Smart interfaces. This refers globally to several different issues like: (i) development and characterization of new surfactants, macromolecules and nanoparticles that modify the gas liquid interface towards enhanced energetic and rheological properties. The above includes also mixtures of materials. (ii) Chemical and physical (morphological) design of superhydrophobic and superhydrophilic solid surfaces. The most challenging task is the development of complex mixed surfaces e.g., patterning hydrophilic areas in superhydrophobic surfaces to control droplet deposition and spreading. Manufacturing of patterned and structured surfaces can be achieved by employing lithography, chemical vapor deposition, etching or other contemporary techniques. (iii) Development of smart nanostructured interfaces controlling heat transfer upon drop impact. (iv) Foam polymerization to produce new foam structured solid materials. (v) Preparation of aerosol particles with specific surface properties. Special care will be paid that all new materials are eco-friendly (biodegradable, reusable, more durable, less energy consuming for their production). An evaluation will be made on the efficiency of the above from small scale tests (V1) to large scale applications (V3).

WG3 Diagnostics

This Working Group refers to development of diagnostics, including identification of systems most representative parameters, measuring principles and techniques, accuracy/sensitivity, conditions and range of applicability, data analysis and interpretation. Diagnostics can be also categorized according to the length scale of measurement. The first category refers to diagnostics for the characterization of single interfaces (V1). On this account, existing techniques for measuring static and dynamic interfacial tension, interfacial rheological properties and film thickness, propagation and rigidity will be revised or improved. The second category (V2) includes determination of bubble/droplet size distribution in clusters improving classical optical techniques or developing modern techniques based on electrical resistance, differential scanning calorimetry, acoustic wave modification etc. The key point for all these V2 diagnostics is how to convert the crude experimentally measured data to valuable results. The transformation is not in general easy and is known as an inverse problem. The study of the direct problem (necessary as prerequisite to the inverse) will be performed in WG1 but the inversion procedure belongs to WG3. Diagnostics that can be examined for the analysis of both V1 and V2 interface systems are digital holographic interferometry, infrared thermography to register the motion of evaporating contact lines, particle image velocimetry, holographic tomography, high speed holography, etc. The last category of diagnostics (V3) refers to techniques exploiting the properties of bubbles/droplets to monitor states of industrial, environmental, or medical interest. Industrial applications include estimation of gas holdup in adsorption/desorption towers, refinery and flotation equipment and in pipelines transporting liquids, e.g., crude oil. Modern environmental applications include fast estimation of pollutants in drinking waters by measuring rising bubble velocity and the use of optical and spectroscopic nanotechnological Quality Control in beverages. Diagnosis of diseases using patterns from blood droplet evaporation, monitoring the motion of carrier droplets for controlled drug delivery, detection of bubbles in the bloodstream during open heart surgery are examples in the medical domain.

WG4 Technology

This Working Group concerns marketed industrial technologies and end-user applications. These technologies include specific products, processes or even computational tools for modeling and optimization that can span from V1 to V3 level (length scales). Applications span a broad range from typical large scale unit operations to food, cosmetic and detergent production and to medical applications. Emphasis is given to industrial methods of generating and dispersing bubbles and drops, control of their population, size and stability. Bioactive encapsulation and controlled release, design of carriers for drug delivery by inhalation, active and passive control of drop formation are also issues of interest in this WG. Moreover, classical industrial processes such as boiling, evaporation, condensation, flotation and more modern ones such as molecular flotation (separation of molecular level entities by bubbles) will benefit from this WG. Additional issues to be dealt in this WG are optimization of oil recovery, green use of emulsifiers, application of natural surfactants in pharmacy/cosmetics/foods, technologies for creation of foams and emulsions with tailor-made properties, surfactant/enzyme mixtures for food digestion and cleaning. All the ensuing technologies will follow the principle of least energy and material consumption to minimize environmental impact. Integrated large scale software tools of the technological processes necessary for the optimization of their efficiency will be developed in this WG. These tools simulate the complete process based on the results of WG1, WG2 and on mean field approaches like multiphase computational fluid dynamics and population balances.

E. ORGANISATION

E.1 Coordination and organisation

Management and coordination:

This Action will run for four years, chaired by the Action Chairperson and coordinated by the Management Committee (MC) following the "Rules and procedures for implementing COST Actions". The Action will provide coordination and scientific networking, while the effective research work of all the groups will be funded by national resources. Four scientific WGs will be launched. The Action will be steered by a MC meeting twice a year. Working Groups will also meet twice a year. Use will be made of the good experience gained in the frame of the COST Action P21.

Having the same organisational structure as the other WGs, an ESR group (ESRG) will be additionally formed. Its members will perform scientific research within the existing WGs, but they will have also specific roles and activities related to their training and career development.

Monitoring and self-evaluation:

To monitor the Action implementation along the four years, a Core Group (CG) will be formed including the Chairs and vice-Chairs of the Action, WG leaders, ESRG leader and the STSM coordinator. The CG will meet formally once per year, with e-mail contact in between. The achievements and effectiveness of the Action will be reviewed in detail every two years: at the mid-term and at the final MC/WGs Action meeting. During these meetings, a session will be dedicated to self-evaluation where an evaluation committee comprising the CG plus 3 invited external experts, plus 3 industrial representatives, plus the DC rapporteur will convene to evaluate the scientific output of the Action, to identify the major achievements, their dissemination and possible routes to further funding for implementation.

Short Term Scientific Missions (STSMs):

STSMs will be used to establish links between partners with emphasis on (a) STSMs between research labs and industry and (b) STSMs of female researchers and ESRs (the latter will be at least 70% of all). A STSM coordinator will be charged with STSM-related activities (calls, selection procedure, reporting). The STSMs calls (and selection processes) will be twice per year

Communication, dissemination and publicity. Action website:

A web manager will be appointed to create and update monthly the Action Webpage, according to COST requirements, and ensure efficient e-mail communication. Both internal communication between the Action members (password-protected) and open information for external public will be ensured. Information on joint scientific publications will be included. Forums for sharing questions/solutions/ideas/data will be active during the Action.

Milestones. Workshops and training activity:

Milestones are the annual meetings of all WGs and the respective progress and self-evaluation reports. The MC will plan and organize topical meetings, workshops (jointly if possible with other EU programmes and invited industries) and conferences. In close collaboration with the ESRG, the MC will coordinate the training activity in the field of the Action (training schools). The Annual workshop (including MC/WGs meetings) will be connected to the Bubble & Drop conference to allow broader dissemination and visibility of the Action outcomes.

E.2 Working Groups

The Action is arranged into the following Working Groups (WGs), which reflect the horizontal levels of the work-plan (section D): WG1: Fundamentals, WG2: Materials, WG3: Diagnostics, WG4: Technology. The oriented horizontal level of the workplan promotes the interaction of scientists working at different length scales (vertical levels) within each WG so it strengthens the Action's networking capacity. Each WG will house a number of ESRs and females from the member states. Apart from that, under the MC coordination and in close cooperation with WGs, a separate group will be formed: Early Stage Researchers group ESRG, containing young participants horizontally from all WGs. The ESRG will be formed as a distinct overarching structure in order to maximize: (i) the transfer of knowledge from experienced researchers to ESRs (teaching, training and joint supervising scientific activities) and (ii) the active involvement of ESRs in overall Action activities (scientific, organizational, leadership, networking, reporting, dissemination and publicity). Each WG and the ESRG will be led jointly by one experimental and one theoretical leading expert in the appropriate field who will be selected by, and report to the MC. They will coordinate the WG/ESRG, organize workshops and training schools/seminars and promote interaction with the other WGs. They will also provide their WGs/ESRG contribution to the annual reports (annual milestone) via reporting on activities within the WGs/ESRG. Each WG and the ESRG will meet twice per year. The second meeting may be held jointly with a large International Conference (e.g. Bubble & Drops) to allow substantial dissemination of the Action's results. During this meeting dedicated to one pre-defined operational task, recent scientific results will be presented, at least one "brain-storming" discussion will be scheduled to encourage the emergence of novel experiments, protocols or approaches; and a round-table with an evaluation of past activities and steering of future tasks will be organized.

E.3 Liaison and interaction with other research programmes

The interaction with other COST Actions and other European and International programmes will be maintained throughout the duration of the programme. These will be achieved via:

1. Fostering links with other relevant EU programmes;
2. Organisation of joint workshops and seminars with other COST Actions on inter disciplinary areas;
3. Organisation of annual WG meetings together with activities (conferences/meetings) of other relevant Actions;
4. Invitation of Marie-Curie Fellows to Training Schools
5. Invitation of European Research Council (ERC) grantees in the area of interfaces research to participate actively in the Action

Partners of this Action already participate in other European programmes and bilateral actions between European countries and some non European countries (Australia, USA, Canada etc) and European/International Bodies (NASA, ESA: European Space Agency).

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas.

Gender balance:

As the number of women working in the domain of interfaces science is traditionally low, this COST Action will be aimed at supporting a gender balance in all its activities. For this purpose, the following measures will be taken:

1. All of the groups of the Action will be encouraged to promote the involvement of female professionals during the following activities: (i) selection of new research recruits (e.g. by hiring female undergraduate students), (ii) selection of personnel for short-term scientific missions, (iii) selection of personnel to attend scientific conferences.

2. Female participants will be encouraged to take part to the MC and lead the WGs.

3. An MC member will be specifically appointed for taking responsibility of gender balance issues.
4. Facilitate participation of females to attend the Action conference/workshops and training schools. For instance, preference for hosts with available children care will be adopted to facilitate participation of mothers accompanied by children.

Involvement of early-stage researchers:

The Action will be committed to considerably involve early-stage researchers. With respect to this, the specific means listed below will be a central pillar of the Action:

1. Organization of annual training schools and seminars for young researchers;
2. Support of STSMs of young researchers between research groups and industries;
3. Exchanges of young researchers between groups;
4. Dissemination, promotion and support of specific opportunities for early-stage scientists (e.g. PhD and post-doc open positions, calls for grants, awards, etc.);
5. Support of young researchers to attend international conferences.

F. TIMETABLE

This Action is supposed to run for four years in order to create an efficient interaction between the groups, build contacts with the many industrial partners, allow workgroups to work efficiently and schedule training events which profit to early-stage researchers. Frequent monitoring will allow to encourage emergent innovations and to eventually re-orientate certain tasks where it appears to be necessary.

Time	Working Groups activities			
	WG1	WG2	WG3	WG4
Year 1	Kick-off meeting & set up of Working Groups			
	WGs/ESRG Progress meetings			
	Training School, STSMs			
	Annual Workshop (including MC/WGs/ESRG meetings)			
	Progress Report (**milestone 1**)			
	WG1	WG2	WG3	WG4
Year 2	WGs/ESRG Progress meetings			
	Training School, STSMs			
	Mid-term conference + MC/WGs/ESRG meetings + Self-evaluation meeting			
	Progress Report + Self-evaluation Report (**milestone 2**)			
	WG1	WG2	WG3	WG4
Year 3	WGs/ESRG Progress meetings			
	Training School, STSMs			
	Annual Workshop (including MC/WGs/ESRG meetings)			
	Progress Report (**milestone 3**)			
	WG1	WG2	WG3	WG4
Year 4	WGs/ESRG Progress meetings			
	Training School, STSMs			
	Last year conference + MC/WGs/ESRG meetings + Self-evaluation meeting			
	Final Report + Self-evaluation Report (**milestone 4**)			

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, BG, CH, DE, ES, FR, EL, IE, IL, IT, NL, NO, PL, PT, RO, SE, SI, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 80 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The Action will use a dissemination plan adapted to each category of its target audience. MC will establish at the beginning of the Action the dissemination strategic plan and will address internal (belonging to the Action) and external target groups by specific instruments. The list of target groups will be discussed and regularly updated.

The following target groups have been identified:

- Universities/Research Institutions/Academies working in topics related to the Action
- Industries in related-fields to the Action (end-product manufactures, diagnostics developers and service providers).
- National and European Research funding agencies
- Other European projects (COST, FP7, EUREKA, RTN, etc.)
- Research funding/performing organisation (e.g. Science Parks or Museums)
- Opinion formers, European-level and regional-level Research Policy decision-makers
- Media: scientific and non-scientific press, digital media and TV
- Early Stage Researchers (graduates, PhD students, young researchers working in the field of the Action)
- General public

H.2 What?

The dissemination plan is designed to achieve a maximum transfer of new knowledge. To maximise the dissemination of the results and progress of this Action several distinct routes will be used:

1. A dedicated interactive website will set up with two levels of access:

   A dedicated website will be set up on a server of one of the partner's institutions. It will include a private area, accessible to the Action partners only and a public area. The website will be maintained by the Dissemination Manager appointed by the MC and supported by the CG.

   (i) Public accessible level

   The public area will allow broad dissemination of the Action outcomes in form of common scientific publication database and information on past and upcoming events. This will contain information about the management structure, contact points and activities of the Action including conferences, workshops, symposia, training schools, training events (both within the network and worldwide), list of potential host groups for technical visits and training. Links to publications and articles in scientific and technical journals, proceedings, job opportunities, project opportunities, PhD and MSc studentships will also be available.

   (ii) Password-protected level

   This access-level will allow private information exchange about available facilities and work in progress for members in WGs and ESRG of this COST Action only. It will contain information about MC meetings, scientific reports, non technical interim and annual reports, STSM reports, financial reports, working papers, guidelines and manuals.

2. Shared electronic documents and an e-mail network will be established for the whole Action.

3. Scheduled meetings will be established: workshops, seminars, retreats and conferences will be organized by the MC, in parallel with national and international conferences and symposia

4. Regular researcher exchanges between sites especially of ESRs.

5. Participation in industrial forums such as “TRIZ-Conference: Current scientific and Industrial Reality - Chamber of Commerce and Industry Frankfurt-Germany”.

6. Training schools and training events will be organized, as well as lectures by leading scientists and engineers from both academia and industry.

7. Links with others Actions, NoE, ITN-MC, NMPs - links will be established with the most relevant funded projects with proximity and/or complementarity objectives.

8. Joint publications in high impact peer-reviewed scientific journals, books and proceedings and presentations to the Action workshops and Conferences.

9. Non-technical publications**:** Press Briefings and Press Releases will be available for public dissemination. Technical publications will be prepared by the respective partners.

10. Visits to the laboratories of partner groups and industries; this is realizable mainly in the host locations of specific Action meetings or Conferences.

H.3 How?

The dissemination strategy follows the integrated communications approach:

- End-user oriented: The Action commits to the end-user by focusing on end-user friendly and end-user active communication.

- Consistent yet adaptable: The Action achievements will be present in a consistent (especially when explaining scientific results) yet adaptable as different target end-users require different sort of information (e.g. some require a specific terminology whereas others require jargon-free information) to receive the same intended information

- Innovative yet appropriate: messages and communications activities will be aligned with the promise they will deliver.

- Feedback-oriented: Feedback tools will be implemented in all applicable dissemination activities. The dissemination strategy will be adapted to arising needs and internal and external communication processes can be improved.

The following selected routes will contribute to dissemination activities:

1. The website will be a vital point for dissemination by providing information about the Action, including the management structure and contact points as well as its activities including conferences, workshops, symposia, training schools, publications and articles and technical journals, proceedings, job opportunities, project opportunities, PhD and MSc studentships, access to scientific, interim and annual reports, case study and STSM reports, device/sample exchange, financial reports, working papers guidelines and manuals.

2. Mailing lists for the committees and members of WGs and the ESRG will allow coordination and information exchange at each level.

3. Workshops, seminars and conference organised by the MC will also be key dissemination points to other research groups and industrial players. Particular attention will be paid to organization of such events in conjunction with other international activities to enable dissemination to broader audiences.

4. Training schools, training events as well as lectures given by leading scientists and engineers from both academia and industry will enable dissemination primarily to ESRs and PhD students. The progress of the Action as well the results of its evaluation will feed in to uploading the dissemination plan during the course of the Action.

5. Training in advanced techniques of science communication will be included in the training activities targeting ESRs.

6. Subject to copyright and licensing arrangements, a copy of publications arising from and supported by this COST Action (including journal articles, books and conference and workshop proceedings) will be deposited in the e-print repository of the COST Office.

7. The Final Evaluation Report will cover the dissemination and exploitation of the results in line with the DC's Terms of Reference

The MC will produce, following the DC's Terms of Reference requirements, a revised dissemination plan and will include it in the annual report to be approved by the DC. Therefore, once the Action begins, there will be a continuous monitoring of the dissemination by checking the following indicators:

(i) Increased number of European scientific workshops and conferences in the field by scientists in the Action.

(ii) Increase in the collaborative work and joint publications between partners of the network.

(iii) Increase in distribution of information and documentation of scientific data and materials via the dedicated Web site.

(iv) Increased number of available PhD and MSc in the Action field.

(v) Increased number of STSMs and participants of training schools, workshops and training events.