European Cooperation in the field of Scientific and Technical Research - COST -

Brussels, 21 November 2012

IC1208

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action IC1208: Integrating devices and materials: a challenge for new instrumentation in ICT (IDEM)

Delegations will find attached the Memorandum of Understanding for COST Action as approved by the COST Committee of Senior Officials (CSO) at its 186th meeting on 20 - 21 November 2012.

MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action IC1208

INTEGRATING DEVICES AND MATERIALS: A CHALLENGE FOR NEW INSTRUMENTATION IN ICT

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 increase the scientific and technical knowledge of the emerging field of integrating devices and materials for new instrumentation in ICT: reflectarrays, acoustic resonators, biosensors, photonic devices, etc. These are envisioned as an indispensable part of the future ICT equipments and instrumentation.

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 24 million in 2012 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

This Action addresses the critical challenge of providing new devices for Information and Communication Technologies (ICT) applications running from sensors to photonics and optoelectronics. Traditional materials –such as liquid crystals– and devices –such as acoustic resonators– are now showing new and improved functionalities when combined with nanostructured materials. This leads to innovative devices, which broaden the horizon of the applications in many areas, from health (bio- and diagnostic sensors) to optical communications and photonics (reconfigurable optics, displays). Interdisciplinarity and improved use of knowledge are essential for undertaking challenges in the design of new devices derived from new materials. The Action will develop new ideas for functional materials and devices in these areas and innovative training curricula for professionals and scientists that encourage an integrated approach to the design and implementation of breaking new devices for photonics, materials engineering (e.g. multiferroic ceramics) and sensor areas.

Keywords: Reconfigurable optics, biosensor, nanostructured liquid crystal, acoustic resonator, nanomultiferroic ceramics.

B. BACKGROUND

B.1 General background

The use of recently developed nanostructured materials offers wide designing possibilities of novel devices for ICT applications. The scientific community interest in this area has been increasing in the last years opening new expectations in a wide range of technologies applicable to many different scenarios: communications, biosensors, health, electronics, etc.

This COST Action aims to include a number of classic ICT technologies (liquid crystals, ceramic materials, electroacoustic devices, sensors) using innovative, intentionally engineered materials to obtain novel devices and to generate scientific progress. The challenge of integrating devices and materials is expressed in the Action name and its acronym: IDEM.

The importance of the IDEM Action relies in the combination of different groups working in diverse disciplines (chemistry, engineering, materials) with a common focus: the scientific development of nanostructured materials and their application in new technologies and devices.

The knowledge exchange derived from this Action will impact not only in the development of novel materials and devices but also in the success of current and future projects being the seed of new collaborations and international projects.

The promotion of new collaborations in areas on the frontier of knowledge is in line with COST programme objectives to fund pre-competitive research activities in new emerging lines. To date, the joint activities among some of the participant groups in this Action have been carried out in an informal way or in previous bilateral projects. To this end, a COST Action offers the most appropriate framework for the coordination and the merge of efforts pursued by the members of the Action; in fact, it will enable developing a suitable program of exchange of both senior and young scientists, which represents the fundamental basis to carry out a coordinated interdisciplinary research like the described one.

The aim is to address novel research topics that are very interdisciplinary and cannot be conducted by any of the participants alone. COST will enable the necessary interaction channels to efficiently collaborate on these topics. These comprise: technical brainstorm meetings, mutual visits to gain deep knowledge of (the possibilities and limitations of) each other's facilities and techniques, short term training programmes for visiting young researchers, etc. In other European research tools there is no time or funding for such explorative and educational activities. The interaction channels established in this COST Action will facilitate, in a later phase, the construction of consortia to apply for regular European research projects.

Very often the gap between the basic studies and strictly application oriented material development was found to be just a matter of time shift between the mentioned aspects. This time shift could be overcome mainly by wide networking between partners binding the application oriented research with the basic one.

B.2 Current state of knowledge

The design and synthesis of liquid crystal (LC) materials have been widely explored for decades [R.Dabrowski, P.Kula, Z.Raszewski, W.Piecek, J.M.Otón, A.Spadlo, *"New orthoconic antiferroelectrics useful for applications"*, Ferroelectric, **395**(1), 116-132 (2010)] [P.Kula, A.Spadlo, J.Dziaduszek, M.Filipowicz, R.Dabrowski, J.Czub and S.Urban, *"Mesomorphic, dielectric, and optical properties of fluorosubstituted biphenyls, terphenyls, and quaterphenyls"*, Optoelectron. Rev., **16**(4), 379-385 (2008)] [European Project VI-th European Frame Program Grant, *"Development of 4k compatible LCOS microdisplay for D-cinema and simulation applications"*, (2006-2008)] covering from the extremely low birefringent, low ordinary index materials to high birefringent positive, negative and dual frequency nematics as well as variety of smectic materials and chiral systems including blue phases. The majority of LC material development is focused now on visible (VIS) wavelengths and a few bands of near infrared (NIR, two main telecommunication bands). There are no liquid crystalline materials with high VIS-NIR-MWIR transparency (mid-wavelength infrared), having nematic phase at operational temperatures and appropriate dielectric properties and high optical anisotropy at infrared and THz wavelengths [M. Reuter, K. Altmann, N. Vieweg, K. Garbat, R. Dabrowski, M. Koch, *"Highly birefringent liquid crystal for THz applications"*, The 7th German Microwave Conference GeMiC'12, Ilmenau (2012)]. There are only a few compounds with very narrow nematic range and high transparency at NIR and MWIR frequencies; current research is going to enhance the nematic range and to tune the dielectric properties of this class of nematogens.

Furthermore, there is a great interest in improving the properties of the existing materials by doping them with nanoparticles and also in developing novel meta-materials in the optical range [W. Wu, E. Kim, E. Ponizovskaya, Y. Liu, Z. Yu, N.Fang, Y.R. Shen, A.M. Bratkovsky, W.Tong, C. Sun, X. Zhang, S.Y. Wang, R.S. Williams; *"Optical metamaterials at near and mid-IR range fabricated by nanoimprint lithography"* Appl. Phys. A, Mat. Sci. Process., **87** (2) 143 (2007)] [A. Monti, F. Bilotti, A. Toscano, L. Vegni, *"Possible implementation of epsilon-near-zero metamaterials working at optical frequencies"*, Opt. Comm., **285**, 3412-3418 (2012)].

All these new materials present multiple possible applications in photonic devices for ICTs such as optical communication components, displays, phase only devices (filters, lenses, beam steerers…) [E. Otón, A. Carrasco, R. Vergaz, J.M. Otón, X. Quintana, M. Geday; *"Improved 2D tunable beam steering–lens device based on high birefringence liquid crystals*". Proc. IEEE 2011 Intl. Conf. on Space Optical Systems and Applications 109-112 (2011)], aerospatial applications and sensors [D. Donisi, L. De Sio, R. Beccherelli, M.A. Caponero, A. d'Alessandro, C. Umeton; *"Optical interrogation system based on holographic soft matter filter"*, Appl. Phys. Lett. **98**, 151103 (2011)].

On the other hand, electroacoustic devices and, in particular, bulk acoustic wave resonators (BAW), are nowadays presented as a new generation of devices for bio-sensing applications as they simultaneously possess the combined merits of all other types of biosensors: label-free, small size (allowing the possibility of arrays for parallel detection), ultra-high sensitivity and low cost. The use of nanomaterials such as graphene, carbon nanotubes (CNTs) or piezoelectric nanowires, holds the promise of improving the performance of existing devices allowing ever increasing sensitivities, analysis speed and selectivity. To this respect, some have been the first groups worldwide to propose, realise and publish a novel technology for replacing metal electrodes on BAW devices with carbon nanotube (CNT) electrodes. Up to date, the results from the existing collaboration have demonstrated that significantly better sensitivity is achieved with these novel electrodes compared to standard metallic ones.

Biosensors and point-of-care (PoC) instrumentation to be used in portable and easy-to-use electronics is a powerful tool for early diagnosis of many diseases. However, to realize the many promising opportunities that these devices offer to transform healthcare, significant progress in the ability to predict, diagnose and monitor cheaply and effectively in real-time and/or at PoC is needed.

New biosensors such as aptamers combined with innovative detection systems such functionalized liquid crystals (LCs) or high frequency resonators with carbon nanotubes working in liquid medium are promising alternatives to develop low cost diagnostic tools for primary assistance [EU Project HEALTH -2012- "*Rapid Aptamer based diagnostics for bacterial meningitis*"].

Recently some kind of magneto-electric responses were observed in the magnetic nanoparticles/LC phase nanocomposites. The coupling between phases is still not well understood and interchange of knowledge between experts is of utmost importance, from fundamental point of view as well as for incorporation of such materials in novel electronic devices. Soft magneto-electric materials were prepared only recently [B. Rozic, M. Jagodic, S. Gyergyek, M. Drofenik, S. Kralj, G. Lahajnar, Z. Jaglicic, Z. Kutnjak, *"Orientational order-magnetization coupling in mixtures of magnetic nanoparticles and the ferroelectric liquid crystal"*, Ferroelectrics, **410**, 37-41 (2011)]; therefore the state of the art will be developed in the near future with the help of the COST Action.

Nanophotonic devices have the capability to concentrate light into the nanoscale range and are of great interest for many applications such as integrated optics, plasmonic circuits, biosensing and quantum information processing. One way to localize the optical radiation into a nanometer-sized volume is actually obtained by using the unique properties of plasmonic nanomaterials. In this framework, the control of plasmonic resonances is a hot-topic and various approaches such as controlling size and shape of the nanoparticles or varying the distance between them are actually used. A more effective control method is to vary the refractive index of the surrounding medium. The outstanding self-organizing properties of liquid crystals make them an ideal candidate for this role, since they provide an "active way" for controlling the plasmonic resonance [L. De Sio R. Caputo, U. Cataldi, C. Umeton; *"Broad band tuning of the plasmonic resonance of gold nanoparticles hosted in self-organized soft materials"*, J. Mat. Chem., **21**, 18967 (2011)].

However, in general, LCs require chemical and/or mechanical treatments to be aligned [M. Sutkowski, T. Grudniewski, W. Piecek, P. Morawiak, J. Parka, E. Nowinowski, Z. Raszewski, *"Holographic Recordings Using Bistable SmC* Structures"*, Mol. Cryst. Liq.Cryst., **502**, 195-206 (2009)]. In addition, the order degree of LCs material is, in general, destabilized by the inclusion of nanoparticles. Recently, it has been reported on the realization of a periodic soft-composite structure, with a wide range of photonic applications, which might represent a solution to these drawbacks [L. De Sio, S. Ferjani, G. Strangi, C. Umeton, R. Bartolino; *"Universal soft matter template for photonic applications"*; Soft Matter. **7**, 3739-3743 (2011)].

In this COST Action these individual areas of expertise will be addressed together on a large scale in a structured way, enabling the tackling of the interdisciplinary research challenges that have until now been largely unexplored.

B.3 Reasons for the Action

The need for connecting the different national research, as well as the growing relevance of interdisciplinary actions, is underlined by the increasing number of recent, relatively small events that tackle topics related to this COST Action:

- "*Designing better care for older people: how technology can make a difference*", Royal Academy of Engineering, May 2012, Sheffield, UK
- *"Conference on Liquid Crystals"*, Poland, from 1973-2011 every two years
- *"OPTON 2012 International Trade Fair for Optoelectronics and Photonics"*, 15-16th May 2012. Poland
- *"Nano(particles) for cell biology"*, Cambridge Nanoforum, June 2012, Cambridge, UK
- *"Biomedical Sensing"*, Photonex 2012, October 2012, Coventry, UK
- *"Mediterranean Workshop and Topical Meeting: Novel Optical Materials and Applications"* (NOMA), Cetraro, Italy, from 1995-2011 every two years

The development of new ICT technologies based on the use of novel materials requires a previous stage of knowledge exchange, effort coordination, and the establishment of an international relevance experts network. This Action allows the strengthening of the inter-group collaborations that should be very difficult to establish under other competitive 7th Framework Programme (FP7) tools.

The immediate benefit derived from the launch of this COST Action will be the training of excellence of young researchers in areas far away from their previous specialties. This interdisciplinary education will enhance the young researchers' abilities in the use of equipment and technologies not present in their laboratories of origin.

This Action will help addressing economic/societal-needs as well. Europe has been losing technological leadership to the Far East. This is happening in all traditional technological areas and is having a dramatic negative economic impact. Some of the strengths of Europe are the strong academic world and the language skills (enabling collaboration over the whole European area). This COST Action will allow using these strengths to establish new leadership in unexplored technological domains that are out of the reach of traditional technological giants.

Development of novel and efficient communication technologies resulting from integrated research activities made possible with this COST Action will be a main enabler for future-generation electronic devices based on emerging materials.

Envisaged applications include, but are not limited to:

- New Liquid Crystalline materials for microwave applications and nanophotonic applications
- Optic communication devices and space applications based on nanodoped and nanostructured LCs, such as Fabry-Perot, Mach-Zehnder and Bragg filters, phase-only retarders and diffractive optics
- Sensors and biosensors based on bulk acoustic wave resonators (BAW)
- New multiferroic materials based on nanoheterostructures for semiconductor nanoparticles, giant dielectric constant ceramics, lead free piezoelectrics and magnetoelectrics for ICT applications
- Photonic devices with application in integrated optics, plasmonic circuits, biosensing and quantum information processing based on interaction of nanoparticles, liquid crystals and polymeric materials
- Novel electro-optic components for the efficient distribution, guidance of light
- Novel sensors based on LC technology (blue phase or classic)

B.4 Complementarity with other research programmes

The Action has complementarities with a number of European research work programmes, related to Nanoscience, Nanotechnologies, Materials and New production Technologies (NMP) as well as Information and Communication Technologies (ICT). Some examples of open calls and running projects:

- NMP – SMEs 2013 (Stimulating the use of newly developed materials and materials technologies by the industry)
- NMP – SMALL 2013 (Nanotechnology for benefiting environment, energy and health)
- ICT-2013.3.3 *Heterogeneous Integration and take-up of Key Enabling Technologies for Components and Systems*
- MPNS COST Action on *Materials and Systems for Optical Data Storage and Processing*
- FP7 Coordinating and Support Action. *ECONAM - Electromagnetic Characterization of Nanostructured Materials*
- FP7-PEOPLE-2009-IRSES. *NOWAPHEN Novel Wave Phenomena in Magnetic Nanostructures*
- Project *Rapid Aptamer based diagnostics for bacterial meningitis (RAPTADIAG)"* of HEALTH-2012- SME for Innovation, aimed to develop new low cost and portable biosensor kits for bacterial diagnosis. Some of the sensors are based on the combination of aptamers with BAW and LC technologies.
- Project *"Self–organized Nanomaterials for tailored optical and electrical properties (NANOGOLD)"*of NMP-2008, aimed to exploit organic-inorganic composite materials containing resonant entities to tune and optimize electromagnetic properties, resonance and interference at different length scales. The project will be concluded this year, and it is evident how both dissemination and scientific results obtained in that framework represent an excellent starting point for all the objectives of the present project.
- Project *"Oxide materials towards a post-silicon era (ORAMA)"*of NMP-2009, aiming to exploit metal oxide thin film materials as an enabler for ubiquitous electronics. Metal oxide semiconductor materials are optically transparent, can be produced in thin films on plastic and have good electronic performance. This project's output could be used to drive sensors or display elements produced in this COST Action.

- Project *“New photonic materials and their advanced applications”* of European Regional Development Fund, aimed to the implementation of new, technologically advanced liquid crystal materials and technologies within the area of photonics supported by the back-up facilities and the accumulated expertise of the said partner and creation of demand for innovative technologies and photonic materials.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The aim of IDEM COST Action is to increase the scientific understanding and technical knowledge of the emerging field of integrating devices and materials for new instrumentation in ICT by exploring and developing the combination of novel nanostructured materials, preparation methods, techniques and devices. The resulting materials and devices are envisioned as an indispensable part of the future ICT equipments and instrumentation.

C.2 Objectives

The main objectives of this COST Action are:

- **O1**: European coordination of research of excellence in the emerging field of ICT devices, which are based on novel nanodoped and nanostructured materials.
- **O2**: Improvement of the technology transfer to gain competitive advantage for ICT European industry.
- **O3**: Establishment of an international reference network of interdisciplinary experts in the field of novel materials for ICT applications.
- **O4**: Early integration of young researchers to facilitate their incorporation to the industry as well as their promotion to senior researchers.

C.3 How networking within the Action will yield the objectives?

To achieve the previous objectives, different tools will be employed inside the consortium:

- Working Group Workshops
- Interdisciplinary Seminars

- Coordination visits
- Short-term scientific mission for researchers
- Early-stage researchers meeting
- European summer school
- Industrial interdisciplinary technologies days
- Handbooks, dissemination and exploitation
- Patents and their subsequent exploitation

C.4 Potential impact of the Action

The benefits of the IDEM COST Action are tightly linked to the main objectives outlined in Section C.2 and will rebound in three different lines.

The achievement of O1 and O3 objectives will contribute to the establishment of an international expert network in the following research areas:

- New Liquid Crystalline materials for microwave and nanophotonic applications, sensors and optic communication devices based on nanodoped and nanostructured LC.
- Sensors and biosensors based on bulk acoustic wave resonators (BAW).
- New multiferroic materials based on nanoheterostructures.

Young researchers will also benefit from the excellent interdisciplinary education derived from this expert network.

The progresses derived from O2 will result in new possibilities for European industry, with the technology transfer from the academic world, in the battle with far East. The ICT industry is one of the European strategic goals from the social and financial points of view for the next decades. Development of novel and efficient communication technologies resulting from integrated research activities made possible with this COST Action will be a main enabler for future-generation electronic devices based on emerging materials.

Finally, a very important impact is the creation of a breeding ground of young researchers and engineers that the ICT industry will need (O4) and at the same time offer to new graduates the opportunity for a highly skilled work. Collaboration with European industries shall be a keystone of the Action. An Industrial Advisory Board (IAB) created within the Action will be the interface between the industrial thread and the partners.

C.5 Target groups/end users

The identified stakeholders among the ICT characters are very diverse going from Biotechnology companies to electronic components developers through health centres.

Different companies have been consulted for the preparation of this COST Action:

- Bioapter, S.L. (Spanish Biotech company)
- Suseo, S.L. (Spanish photonic components SME)
- Visual Display, S.L. (Spanish Display SME)
- Laboratory of Gastrointestinal Pathogens (UK Health Protection Agency)
- CaLCTec s.r.l., (Calabria Liquid Crystal Technology, IT)
- Lasertex (R&D Polish company specialized in advanced laser interferometers)

A number of companies will be invited to participate in the above mentioned Industrial Advisory Board (IAB).

Finally, the entire population is the potential end user of the proposed devices, since the Action is focused to a number of devices, from biosensors to communication components, having an ample range of application.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

This COST Action will coordinate research, anticipating solutions for the need of next generation ICT devices based on unconventional nanostructured materials. The Action is supported by four pillars:

1. Development of new liquid crystals working at infrared and microwave range.
2. Nanostructured materials based on the combination of nanoparticles (nanotubes, nanorods, nanowires) with self-organized systems (e.g. ferroelectric liquid crystals).
3. Aptamers as active specific sensing nucleic-acid chains for the construction of portable biosensors.

4. Multiferroic ceramic nanoheterostructures.

On the basis of these four pillars, several devices are proposed in this preliminary stage as an open list of possible objectives for the development of ICT technologies. As the project progresses new proposals will be included in the work schedule.

This Action will build on long experience in materials engineering of liquid crystals (LCs), particularly state-of-the-art realizations such as orthoconic antiferroelectric smectics, high birefringence or negative anisotropy nematics as well as their composites with functional polymeric networks. These materials show superior performance in dynamic response, bistability, phase-only switching, etc. These properties are further boosted by doping with nanoparticles of specific size, shape (nanorods, nanotubes), composition and electrical behavior.

Adaptive and tunable electro-optical components: the combination of novel liquid crystal modes such as polymer stabilized blue phases with microstructured polymer surfaces and/or with nanosized particles is a promising route towards the creation of a whole new range of electro-optical components. While the basic operating principles are long known, it is only recently that new liquid crystal modes with fast switching behavior (even for thick layers) have become feasible. Furthermore, progress in nanoparticle technology and microstructuring or polymer with optical qualities has brought these technologies to unseen levels that are ready to be combined with the innovative LC technologies. The main objective now is to start exploring the vast area of new opportunities that this has created. Starting from basic test structures to assess the predicted operation, this COST Action will gradually move to more complex components that exhibit presently non-existing functionalities.

The search for coupling of properties in multiferroic ceramics is relevant for the development of new and unusual applications. So far multiferroics are afforded in single phase and composites but only nanoheterostructures found relevant properties. Ceramic grain size generally does not fit the crystallite size due to the presence of crystalline defects. It is necessary to understand the role of crystalline defects and size effects in their functional properties.

The study will focus on selected materials in which the groups show expertise and international recognition: semiconductor nanoparticles, giant dielectric constant ceramics, lead free piezoelectrics and magnetoelectrics. The cooperation will allow this COST Action to compare different processing routes to obtain from nanoparticles to dense nanostructure ceramics with different crystal defects, size effects and dimensionality.

On the other hand, biosensors for health point-of-care (PoC) instrumentation are other challenging objective for the new European society. Significant progress in the ability to predict, diagnose and monitor cheaply and effectively in real time and/or at PoC is needed. New biosensors such as aptamers combined to innovative detection systems such as functionalized LCs or high frequency resonators with carbon nanotubes working in liquid medium are promising alternatives to develop low cost diagnostic tools for primary assistance. LC and micro/nanoluminophores may be used as converters of X-ray into visual effect with low radiation exposition.

Bulk acoustic wave resonators (BAW) are heavily used in biosensing applications, as they possess the combined merits of all other types of biosensors: label-free, small size, arrays for parallel detection, ultra-high sensitivity and low cost. However selectivity to different biological species must be enhanced. Some groups have proposed, realized and published a novel technology for replacing metal electrodes on BAW devices with carbon nanotubes (CNT), demonstrating significantly better sensitivity with these novel electrodes.

Chemically functionalizing CNTs or piezoelectric nanowires for direct bonding to specific biological molecules would prevent non-specific binding and the need of additional sensitizing layers. The success of this Action will bring an early development of this highly sensitive and innovative technology allowing the applicants to gain a technological lead in the world.

D.2 Scientific work plan methods and means

This COST Action will establish several working groups to interchange knowledge and people.

WG1: LC modification with nanostructures

Combining gold nanoparticles (NPs) and CNTs with LC phases produces new systems keeping the properties of LCs and the localized surface plasmon response of very well dispersed NPs. Additionally, it has recently become feasible to realize a Blue LC Phase that is stable in a wide temperature range. The interaction of polymer nanostructures with LC molecules is a vast and unexplored area of research with tremendous potential. Functionalization of the LC ordering and stabilization of screw dislocations −like in case of Blue phases, smectic phases and TGB phases−as well as the impact of functionalization of NPs of various shapes ranging from graphene and laponite disks and spherically shaped plasmonic, semiconducting and magnetic nanoparticles are essential as well.

Recently the first soft magneto-electric, as a new subgroup of multiferroic materials, was prepared, by mixing magnetic nanoparticles and LC phase. A study of the influence of the magnetic nanoparticles surface properties on the mechanism of coupling with different LC phases appears to be fundamental.

WG2: Biosensors and reading electronics

Novel biosensors based on BAW resonators, where a thin film of CNTs or graphene layer doubling as electrode and sensing layer, will be jointly developed. This technology would solve many of the issues of existing biosensors in terms of sensitivity and selectivity. To successfully realize this goal, the expertise of several applicants in BAW resonators design and fabrication, nanostructures growth and characterization, and electronics integration is essential.

Novel biosensors based on BAW resonators and LC cells having active surfaces coated with highly specific aptamers for detection of food-borne pathogens in simple, portable units will be prepared.

WG3: New ICT devices based on reconfigurable LCs and unconventional materials

A polymeric template can be used to introduce a preferential alignment to LCs doped with metal nanoparticles as well as photosensitive and photo-oriented additives. It has been recently demonstrated that the plasmon resonance spectral position of these NPs can be dynamically controlled. This kind of research can lead to the realization of active plasmonic devices. Similar structures comprising NPs of crystalline materials with strong nonlinear optical properties are expected to be promising for realization of active multispectral optical devices.

Furthermore, the combination of micro- and nanostructured optical surfaces with Blue Phase LCs allows the realization of smart optical components with switchable or tunable optical functionality.

WG4: Tools for Integration; Tools for Dissemination

Continuous exploration of new funding resources will be performed by contacting new European research groups and companies that could collaborate with the COST Action. Visibility and dissemination of results will be of major importance for this task. Attendance at conferences worldwide and the organization of specific workshops will be the most powerful tools for the success of this WG.

E. ORGANISATION

E.1 Coordination and organisation

The origin of the Action lies on the active collaborations already established among research groups, which belong to different areas of expertise. Once identified additional possible links within the whole COST Action, the Action appears as a powerful tool to coordinate the intermixing for improving the collaboration and generating new ideas and products. Thus, organisation will basically focus on boosting relationships between those participants that have not collaborated so far and improving those that already exist. The cooperation of partners with complementary expertise should result in innovative ideas based on the work area. As a result, new consortia will be created to apply for and develop new projects in EU or National calls.

A Management Committee (MC), consisting of Delegates from the Signatory countries, will be responsible for coordinating all the activities within the Action. The chairperson of the Action will have overall responsibility for the timely completion and delivery of the reports to the COST Office. The MC will be supported by a secretariat or administrative office responsible for the financial issues. The MC will meet at least once every year.

The technical coordination of the Action will lie with the Steering Committee (SC), composed of the Chair of the Action, the Vice Chair, a coordinator from each Working Group (WG) and additional members, who may are beneficial for the proper implementation of the Action. The SC will meet regularly and will act as the main driving force to ensure together with the MC that the Action achieves its technical objectives. The meetings of the SC will coincide with the MC meetings, whenever feasible. During these meetings, the SC will report on the technical progress and achievements within the Action and propose new directions and strategies of the Action.

One of the main tasks of this Action will be the coordination of the potential projects, particularly those from national programmes, in which only people of a given country can participate. A Prospective Board (PB), composed of a representative from each country, will coordinate the applications to national and EU calls to harmonize objectives, consider budgets and merge results. A Dissemination Board (DB) will counsel on the advisability of either publishing or patenting the results. This committee will also be in charge of keeping the Action website updated, as required in the call. These two committees will be supervised by the MC.

The Industrial Advisory Board (IAB), already mentioned, will be invited to meet at least once a year, preferably coinciding with MC meetings and workshops. The SC will keep the IAB abreast of progress and achievements within the Action. In the same way, the IAB will make suggestions to SC about the most interesting R&D topics for the companies. The IAB will also identify companies where young researchers may carry out short stays. The IAB composition will be dynamic: new companies may be invited to join depending on their involvement in Action activities.

The first milestone of the MC will be to evaluate the status of the collaborative work currently carried out within the COST Action. This will enable to be established links between these collaborations and new potential ones. This will specifically determine the working areas and short term tasks.

Simultaneously, as a second milestone, accurate information about future funding calls (including dates, budgets and objectives) will be gathered by the PB.

Short stays of researchers in other labs or companies will be the most useful method for an actual exchange of know-how and ideas. Therefore, as third milestone, the SC will schedule a plan of visits and meetings in the different research centres, once the working areas are established. Special care will be taken in setting a formation plan for the youngest researchers of the consortium (post-doc scientists, PhD students and, also, undergraduate students), including short term stays in foreign research centres of the consortium to receive training and acquire knowledge in techniques and methods that are not available in their own centres.

Workshops or summer schools will be organised simultaneously with the MC meetings to present the work in progress within each WG. Distinguished experts will be invited to participate in these events to strengthen links and interactions of the Action with research centres inside and outside Europe.

E.2 Working Groups

Since the different participants in the Action have own projects that require a dedicated and independent research effort, a WG structure is needed to coordinate them and to improve productivity on the basis of sharing results and know-how. Additionally, the WG structure will ease the incorporation into the Action of new research groups, which will collaborate with the participants in the Action in the future. The description of the WG can be found in the Scientific Programme section. Most participants collaborate in most of the WGs, which allows a fruitful exchange of ideas between them. Each WG will be organised by a Coordinator belonging to the SC. The Coordinator and representative researchers of the participants in each WG will meet regularly to technically manage the WG work. The Coordinator will be the link between the SC and the WG and will inform about the guidelines from the SC to the participants in the Action. He/she is responsible for collecting information of all the new relationships with other research groups and evaluating, together with the SC, the incorporation of these new groups into the Action.

E.3 Liaison and interaction with other research programmes

All the participants in the Action are developing R&D projects through local, national and international programmes. Most of them are related to some extent with the work scheduled in this Action. These projects are the starting point of the Action. Future projects will specifically focus on actual tasks scheduled within the Action. All participants are committed to look for funding to reinforce these research tasks; the Prospective Board will be the coordinator for all of them.

Interaction with other existing European and international research programmes dealing with related topics will be actively pursued. Likewise, the collaboration with other international research programmes and bilateral relationships with technological companies worldwide will be promoted.

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

Post-doc scientists and PhD students are essential members of the research teams. Their enthusiastic attitude is a great stimulus for the research teams, in particular in universities, where the teaching activity is one of the main tasks.

F. TIMETABLE

The duration of this Action is four years. At the kick-off meeting, MC, WGs, DB and PB will be established; the executive positions in MC of each WG will be determined. A website and e-mail communication list will be launched at the latest within three months after the kick-off meeting. The MC will meet at least once a year. At least one of the WG, DB and PB meetings will take place simultaneously with the MC meetings. The activities within each WG will be carried out to achieve the main milestones following this timescale:

Phase 1 Mo1-Mo12	***Kick-off meeting***	-Establishment of Management Committee (MC), Working Groups (WG), Steering Committee (SC), Dissemination Board (DB) and Prospective Board (PB) -Scientific-technical meeting -Identification and selection of the most promising issues to be investigated and evaluated in detail.
	Mo6	-SC report on follow-up. Call for first workshop. -PB report on regional, national, and international calls for funding. -Web page and internal electronic updates -Updated literature survey and development of common reference scenarios.

		- Establishment of an IPR agreement -Establishment of Industrial Advisory Board (IAB)
Phase 2. Mo13-Mo42	***Months 13-24***	-First workshop by Mo13. -Detailed workplan based on outcomes of Phase I. -Preliminary test cases drafted and executed on appropriate equipment. -Decision on participation in specific funding calls.
	Months 25-42	-Second workshop ca. Mo25. -Third workshop ca. Mo37. -Evaluation of the resulting test vehicles. -Evaluation of dissemination results. -Evaluation of visits and training programs.
Phase 3. Mo43-Mo48	***Months 43-48***	-Final workshop ca. Mo47. -Review of achievements for widest dissemination. -Assessment of developed methods, models, techniques, strategies, and tools. -Final results collected and evaluated. -Final report completed (Mo48).

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: BE,ES,IT,PL,SI,UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 24 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?

Two levels of dissemination targets must be identified: on the one hand, the members of the Action and, on the other hand, external targets.

Internal dissemination of results and knowledge shall be controlled by the coordinators of each WG, paying special attention to preserve confidentiality in the cases of IP (intellectual property) sensible issues.

There are several external targets that should be considered for dissemination. One of the most important is the scientific community, which will be reached through articles in specialized journals and conference communications to specific conferences and symposia. Research frameworks in which the participants in the Action would be member are good forum for dissemination and for interacting with other researchers working in the field. Industrial agents are another key-target, as the main interest of the Action is the technological development, and industrial agents are intended to be the final-users of the results. Other important targets for dissemination are the young scientists since the Action has the determined objective of training and education and they will be the vehicle to expand the knowledge worldwide.

H.2 What?

The main objectives of dissemination and publicizing are to contribute to the general scientific and technological knowledge and to attract industrial agents as final users of the developments of the research centres. These two objectives must be managed in different ways. One has to distinguish between results that contribute to general knowledge and those that could be object of direct industrialization. These last should be treated in a more confidential way and be the object of IP protection. In the first stages of the COST Action, the MC must reach a consensus between the participants to establish the IP issues and policies.

In the first stages of the Action the main objective of dissemination will be to promote the visibility of the consortium, its ideas and intentions. Once the consortium starts to generate results, the tools for their dissemination will be used according to the objectives.

H.3 How?

The internal dissemination of the project results will be ensured by posting them on a private website, which can be only accessed by the members of the Action through password protection.

For external agents, the methods of dissemination of the knowledge generated in the Action will be those commonly used, such as posting the information on a public website, presenting communications in conferences and publishing scientific papers in regular journals. Other ways of dissemination addressing targets out of the scientific community will be implemented; industrial targets will be approached directly by proposing specific meetings after identifying the companies potentially interested in the results. For this purpose, demonstrators will be generated.

The existence of universities in the COST Action eases the recruitment of graduate students for doing a PhD in the frame of the Action, which, additionally, gives rise to an internationalization of this formation as a supplementary benefit. Conferences and seminars in educational centres by the distinguished members of the consortium will be an asset for this task.

The plan of dissemination must be dynamic and flexible. The Dissemination Board will coordinate the actions by finding the best targets, methods and moments for presenting results or making publicity and dissemination actions.

DB mission goes beyond the simple coordination of the task of publication of results. The creation of a lobby around the new concepts in ICT materials and devices developed by the members of the Action is the most important task of this Board. Partners must contribute to the generation of this lobby by adequately citing the Action and publicizing it and its doings beyond their own results.

Intellectual properties (IP) resulting from this collaboration will be protected through patent applications with the assistance of each University's commercialization organizations. Furthermore, the applicants' existing links with industry will be used to ensure that potential routes for commercialization are explored.