

Graphene appointed an EU Future Emerging Technology flagship

The European Commission has chosen Graphene as one of Europe's first 10-year, 1,000 million euro FET flagships. The mission of Graphene is to take graphene and related layered materials from academic laboratories to society, revolutionize multiple industries and create economic growth and new jobs in Europe.

Graphene has been subject to a scientific explosion since the groundbreaking experiments on the novel material less than ten years ago, recognized by the Nobel Prize in Physics in 2010 to Professor Andre Geim and Professor Kostya Novoselov, at The University of Manchester. Graphene's unique combination of superior properties makes it a credible starting point for new disruptive technologies in a wide range of fields.

With today's announcement Europe is launching a new form of joint, coordinated research initiative of unprecedented scale. The Graphene Flagship brings together an academic-industrial consortium aiming at a breakthrough for technological innovation. The research effort will cover the entire value chain from materials production to components and system integration, and targets a number of specific goals that exploit the unique properties of graphene.

Key applications are for instance fast electronic and optical devices, flexible electronics, functional lightweight components and advanced batteries. Examples of new products enabled by graphene technologies include fast, flexible and strong consumer electronics such as electronic paper and bendable personal communication devices, and lighter and more energy efficient airplanes. On the longer term, graphene is expected to give rise to new computational paradigms and revolutionary medical applications such as artificial retinas.

From the start in 2013 the Graphene Flagship will coordinate 126 academic and industrial research groups in 17 European countries with an initial 30-month-budget of 54 million euro. The consortium will be extended with another 20-30 groups through an open call, issued soon after the start of the initiative, which will further strengthen the engineering aspects of the flagship. The flagship will be coordinated by Chalmers University of Technology based in Gothenburg, Sweden. Director is Professor Jari Kinaret who will lead the research activities together with the leaders of the 15 work packages. The management team is supported by a Strategic Advisory Council that includes the European Nobel Laureates Sir Andre Geim (chairman), Albert Fert, Klaus von Klitzing and Sir Kostya Novoselov, industrial representatives from Nokia and Airbus, and two representatives of the global graphene research community.

"Although the flagship is extremely extensive, it cannot cover all areas. For example, we don't intend to compete with Korea on

graphene screens", says the Professor Jari Kinaret at Chalmers University of Technology, Sweden, Flagship Director. "Graphene production, however, is obviously central to our project."

During the 30 month ramp-up phase, the Graphene Flagship will focus on the area of communications, concentrating on ICT and on the physical transport sector, and supporting applications in the fields of energy technology and sensors. After the ramp-up phase, the flagship will grow to full size and include many new groups and activities. The details of flagship implementation after the ramp-up phase are still open and form a part of the discussions on the Horizon 2020 research program of the European Union.

For more information, please contact:

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The Graphene Flagship's delegation at the European Commission press conference is represented by

Prof. Jari Kinaret, Graphene Flagship Director, Chalmers University of Technology, Gothenburg, Sweden

Prof. Karin Markides, President of Chalmers University of Technology, Gothenburg, Sweden

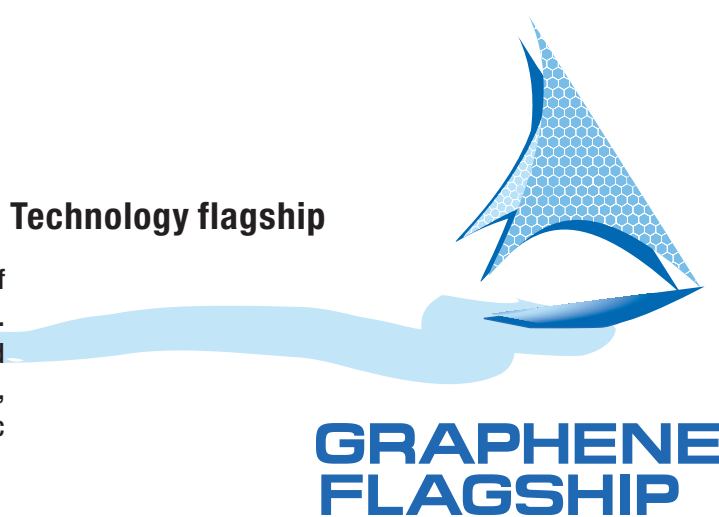
Prof. Andrea Ferrari, University of Cambridge Cambridge, United Kingdom

Prof. Sir Konstantin Novoselov, University of Manchester Manchester, United Kingdom

Dr. Tapani Ryhanen, Nokia Research Center, Espoo, Finland

A number of flagship representatives will be present, available for interviews. Please contact Christian Borg for appointments and details

More information on the EU Future Emerging Technology Flagship Initiative: <http://goo.gl/Q2pBr>





GRAPHENE FLAGSHIP

Work Package 1:



Materials

The “Material” group focuses on two key challenges for the development of a new graphene technology for large-scale manufacturing of graphene-based products: access to high quality uniform graphene and other layered materials. Prior to large scale production, developing laboratory scale protocols for graphene synthesis with targeted properties is essential for this group. This scientific group is in charge of studies of how to combine graphene with other materials in heterostructures - all this will play a key role in validating graphene as a disruptive nanotechnology platform for real-world devices.

Work Package Leader:
Work Package Deputy:

Prof. Mar Garcia Hernandez, Consejo Superior de Investigaciones Cientificas, Spain
Prof. Jonathan Coleman, Trinity College Dublin, Ireland

Work Package 2:



Health and Environment

The “Health and Environment” group takes care of nanosafety research as an essential requirement that cannot be dissociated from the development of new nanotechnologies. The small size and unique physico-chemical properties of graphene pose potential risks to humans and the environment associated with the small size and unique properties of graphene and other layered materials will be explored. The identification and resolution of any possible safety and toxicity issues is crucial not only for their integration into ICT, composites, etc., but also in view of their possible biomedical applications, such as direct nano-interfacing devices with cells and tissues.

Work Package Leader:
Work Package Deputy:

Prof. Maurizio Prato, University of Trieste, Italy
Prof. Alberto Bianco, Centre national de la recherche scientifique, France

Work Package 3:



Fundamental science of graphene and 2D materials beyond graphene

Fundamental and blue-sky studies of graphene and complementary 2D materials have a twofold aim for the group “Fundamental science of graphene and 2D materials beyond graphene”. The group studies the fundamental mechanisms that determine and may limit the potential of graphene in already foreseen electronic and optoelectronics applications, and develop a second generation of graphene-based nanostructures for the development of electronic devices beyond the complementary metal oxide semiconductor field effect transistor (CMOS). The study of 2D materials beyond graphene is key to enhance graphene’s properties by combining this material with monolayers of 2D crystals in superstructures, which will allow broadening of the range of functional applications of graphene and hybrid superstructure in post-complementary metal oxide semiconductor (CMOS) electronics.

Work Package Leader:
Work Package Deputy:

Prof. Vladimir Falko, University of Lancaster, United Kingdom
Dr. Alberto Morpurgo, University of Geneva, Switzerland

Work Package 4:



High frequency electronics

The “High frequency electronics” group targets an establishment of graphene based high frequency analog electronics, capable of significantly outperforming state-of-the-art technologies. Based on this work, establish a clear and detailed roadmap for developing graphene as the next generation of high-performance electronics.

Work Package Leader:

Dr. Daniel Neumaier, Gesellschaft für Angewandte Mikro- und Optoelektronik (AMO) GmbH, Germany

Work Package Deputy:

Prof. Herbert Zirath, Chalmers University of Technology, Sweden

Work Package 5:



Optoelectronics

The “Optoelectronics” group aims to establish a new field of graphene photonics and optoelectronics, sustained by the convergence and co-integration of graphene-based electronic and photonic components such as lasers, switches, optical waveguides, optical frequency converters, amplifiers, cavities, modulators, photodetectors, nano-photonics components, metamaterials and solar cells.

Work Package Leader:

Prof. Andrea Ferrari, University of Cambridge, United Kingdom

Work Package Deputy:

Dr. Frank Koppens, Institute of Photonic Sciences, Spain

Work Package 6:



Spintronics

The main goal of the group “Spintronics” is an establishment of the ultimate potential of graphene for spintronics, targeting efficient room temperature spin injection and detection but also spin gating and spin manipulation in graphene spintronic devices. Spin transport mechanisms in graphene devices will be explored using different materials, and by comparing the results with realistic theoretical simulations, the group works towards the demonstration of novel types of functional graphene spintronic devices.

Work Package Leader:

Prof. Bart van Wees, University of Groningen, The Netherlands

Work Package Deputy:

Prof. Stephan Roche, Fundació Privada Institut Català de Nanotecnologia, Spain

Work Package 7:



Sensors

As a main goal of the “Sensors” group a development of sensing devices based on graphene membranes is conceived. In particular, sensitive read-out for a variety of sensor applications will be developed up to the proof-of-principle stage, supported by modeling activities.

Work Package Leader:

Prof. Herre van der Zant, Technical University of Delft, The Netherlands

Work Package 8:



Flexible electronics

The “Flexible electronics” group investigates the application of graphene to key enabling technologies required for the realization of flexible electronic devices and systems. It has a technology integrator role between other scientific work packages and thereby this work will have connections to the major part of initiative.

Work Package Leader:

Dr. Jani Kivioja, NOKIA Research Center, United Kingdom

Work Package Deputy:

Dr. Luigi Occhipinti, ST Microelectronics, Italy

Work Package 9:



Energy applications

Taking advantage of availability of various forms of graphene within the Flagship, the objective of the “Energy” group is to assess their interest in various daily life energy applications. By focusing on specific functions involved in applications including photovoltaics, energy storage, fuel cells and hydrogen storage, the “Energy” group intends to connect the fundamental and technological graphene expertises to the designers and developers of energy conversion and storage devices and explores novel research routes for future graphene-based material which could better match the energy application needs.

Work Package Leader:
Work Package Deputy:

Dr. Etienne Quesnel, Commissariat à l'énergie atomique et aux énergies alternatives, France
Dr. Vittorio Pellegrini, Consiglio Nazionale delle Ricerche, Italy

Work Package 10:



Nanocomposites

The scientific and technological challenge addressed in the “Nanocomposites” group originates from a simple but fundamental concept: the impressive properties quoted for graphene refer to individual, defect-free sheets, usually obtained by mechanical exfoliation, and suspended to avoid interaction with any perturbing substrate. In many applications, however, graphene layers with properties inferior to the ideal ones will need to be used. In order to have an impact upon society, the ideal properties of graphene sheets will have to be transferred from the atomic scale to the meso- or macroscopic level (continuous layers or bulk materials).

Work Package Leader:
Work Package Deputy:

Dr. Vincenzo Palermo, Consiglio Nazionale delle Ricerche, Italy
Dr. Xinliang Feng, Max-Planck Gesellschaft, Germany

Work Package 11:



Production

Implementation of growth technology and commercial exploitation of bulk graphene / graphene films at the equipment and material level is perceived as an essential goal for the group “Production” as well as evaluation of production scalability, reproducibility and cost of production/ownership. This work package will be aligned with projects on large scale production of graphene funded by the EC through its NMP programme.

Work Package Leader:

Dr. Ken Teo, Aixtron Ltd., United Kingdom



Austria

Technische Universität Wien

Varta Micro Innovation GmbH

Belgium

Universite Catholique De Louvain

Denmark

Danmarks Tekniske Universitet

Finland

Aalto-Korkeakoulusaatio

Nokia OYJ

Teknologian Tutkimuskeskus VTT

France

Centre National de la Recherche Scientifique

Commissariat A L Energie Atomique et Aux Energies Alternatives

Fondation Europeenne de la Science

Thales SA

Universite de Strasbourg

Universite des Sciences et Technologies de Lille - Lille I

Germany

Albert-Ludwigs-Universität Freiburg

Alcatel-Lucent Deutschland AG

Friedrich-Alexander-Universität Erlangen Nürnberg

Gesellschaft für Angewandte Mikro- und Optoelektronik mit Beschränkterhaftung

Max Planck Gesellschaft zur Förderung der Wissenschaften E.V.

Rheinisch-Westfälische Technische Hochschule Aachen

Technische Universität Chemnitz

Technische Universität Dresden

Technische Universität Hamburg-Harburg

Universität Hamburg

Universität Regensburg

Greece

Foundation for Research and Technology Hellas

Panepistimio Ioanninon

Technological Educational Institute of Crete



GRAPHENE FLAGSHIP

Ireland

Trinity College Dublin

University College Dublin, National University Of Ireland

Italy

Consiglio Nazionale delle Ricerche

Fondazione Bruno Kessler

Fondazione Istituto Italiano di Tecnologia

Politecnico di Milano

Politecnico di Torino

STMicroelectronics srl

Universita Degli Studi di Trieste

Poland

Instytut Technologii Materialow Elektronicznych

Portugal

Universidade do Minho

Spain

Agencia Estatal Consejo Superior de Investigaciones Cientificas

Airbus Operations SL

Asociacion - Centro de Investigacion Cooperativa en Nanociencias - Cic Nanogune

Avanzare Innovacion Tecnologica SL

Centro de Investigacion Cooperativade Energias Alternativas Fundacion

Fundacio Institut de Ciencies Fotoniques

Fundacio Privada Institut Catala de Nanotecnologia

Graphenea S.A.

Grupo Antolin-Ingenieria S.A.

Repsol YPF S.A.

Universidad de Castilla - La Mancha

Universitat Autonoma de Barcelona

Sweden

Chalmers Tekniska Högskola AB

Karolinska Institutet

Linköpings Universitet

Stiftelsen Chalmers Industriteknik

Umeå Universitet



GRAPHENE FLAGSHIP

Switzerland

Eidgenoessische Materialprüfungs- und Forschungsanstalt

Eidgenoessische Technische Hochschule Zürich

Universitaet Zürich

Universität Basel

Universite De Geneve

The Netherlands

Philips Technologie GmbH

Rijksuniversiteit Groningen

Stichting Katholieke Universiteit

Technische Universiteit Delft

Turkey

Sabanci University

United Kingdom

Aixtron Limited

Lancaster University

Nokia UK Limited

NPL Management Limited

Oxford Instruments Nanotechnology Tools Limited

The Chancellor, Masters and Scholars of the University of Cambridge

The Chancellor, Masters and Scholars of the University of Oxford

The University of Manchester

University College London



GRAPHENE FLAGSHIP

Why is graphene regarded as such a revolutionary material?

Graphene, a single layer of carbon atoms, may be the most amazing and versatile substance available to mankind. Stronger than diamond, yet lightweight and flexible, graphene enables electrons to flow much faster than silicon. It is also a transparent conductor, combining electrical and optical functionalities in an exceptional way.

How is graphene produced today, and will be in the future?

There are several methods of producing graphene that can be extended to industrial scale. For electronics applications, high quality graphene can be produced starting from silicon carbide or by a technique known as chemical vapour deposition. For bulk applications in nanocomposites or printed electronics, natural graphite can be used to create graphene flakes. Finally, direct chemical synthesis can be used to create small graphene structures with well-defined geometries.

What is the unifying goal of the Graphene Flagship?

Graphene flagship aims at creating new disruptive technologies by bringing together academic and industrial research working towards a common goal. Just as biomedicine research these days translate rapidly into new medical application, breakthroughs in graphene research can translate quickly into products with superior or completely new functionality compared to existing ones, changing the industrial game.

Which are the early breakthroughs and applications we will see?

Flexible touch screens, rollable e-paper, foldable OLEDs, light and strong composite materials and other applications based on low-grade graphene are expected to be commercialized over the next few years.

Looking ten years ahead, what more will there be?

The more advanced applications such as electronics operating at terahertz frequencies, new computational paradigms exploiting the spin rather than charge of the electrons, and advanced medical devices such as artificial retinas are examples of longer term applications.

Which are the main partners behind the consortium?

The consortium includes 74 separate legal entities from 17 countries, many with multiple research groups. A complete list of partners is available at the website. Examples of academic partners include the universities of Manchester and Cambridge in the UK, the Max Planck Society in Germany, CEA and CNRS in France, CSIC in Spain and CNR and IIT in Italy. Examples of

industrial partners include large companies such as Nokia, Airbus, Philips and ST Microelectronics and SME's such as Graphenea.

How is the Graphene Flagship organized?

The flagship will be coordinated by the Chalmers University of Technology that is responsible for the central functions and management. The research work is divided into 11 scientific and technological work packages and supported by work packages on innovation, dissemination, management and administration. The research activities across the flagship are coordinated by a scientific panel comprised by the Director and the leaders of the scientific and technological work packages. The operative leadership is supported by a Strategic Advisory Council that includes nine high level academic and industrial representatives.

Are there other investments in graphene research in Europe apart from the flagship?

Yes, many member states and private funding agencies invest substantially in graphene research on the national levels. As examples we can give a UK investment of 70 million GBP, a Polish investment of 60 million PLN, in Denmark 54 million DKK, in Sweden 69 million SEK and so on. The national investments run over different periods but add up to about 50 million euro per year. Above this, there are substantial investments by European industries in graphene technologies; their overall investment is hard to estimate quantitatively.

How will the flagship ensure that industrial innovation really occurs in Europe?

The industrial and academic researchers will work side by side in the 11 scientific and technical work packages. In addition, we will implement special measures aimed at European industries such as industrial workshops and other dissemination activities. The open call that we will publish early on will focus on engineering aspects of graphene and other layered materials, and we hope that it will bring in additional large and small enterprises into the flagship consortium.