

Graphene Commercialization Conference Report – IMAGINENANO 2015

Farzan Ghavanini March 10-13, 2015 Bilbao



Summary

Graphene commercialization has started to gain momentum. This is witnessed by the arrival of graphene-enhanced products to the market. The list is still short but includes, for example:

- High performance sport products such as tennis racquet and skies from Head
- High performance bicycle rims from Vittoria
- Oil drilling fluid from Graphene Nanochem
- Flexible battery strap from Vorebeck
- Printed RFID antenna using graphene ink by Vorebeck

The graphene market size is still very small and is estimated to be below **\$20M** in 2015, most of which consumed by the R&D sector and universities. In comparison, the market size for carbon nanotube was around **\$350 M** in 2014. It took many years for carbon nanotubes to gain momentum and similar is expected for graphene. Conservative predictions estimate the graphene market size to be more than **\$130 M** in 2020. The relatively slow growth of the graphene market is attributed to the lack of a "Killer Application" and the fact that the production infrastructure is still being shaped. However, once the cost of production reduces, it is expected to see graphene in the market in new application areas. The medium term applications could consist of:

- Flexible TCF (Transparent conductive film)
- Battery electrodes
- ESD mats
- Supercapacitor electrodes

In a longer time perspective one may expect to see graphene in applications such as:

- DNA sequencing and Bio-sensors
- Reinforced polymers
- Anti-corrosion coatings

• Transistors and electronics

Nevertheless, one should note that the graphene market is extremely active and changes very rapidly. Therefore, it is important to closely monitor the market changes and adopt strategies accordingly. This report intends to provide an overview of the latest activities which are commercially relevant.

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Introduction

Bilbao was the host of the 3rd edition of the largest European event in nanoscience & Nanotechnology, ImagineNano, from the 10th until the 13th of March 2015. Bilbao is the capital of the province of Biscay in the autonomous community of the Basque Country with a population of over 300,000. Bilbao is situated in the north-central part of Spain, some 14 kilometers south of the Bay of Biscay, where the estuary of Bilbao is formed.

The conference was held at the magnificent Bilbao Exhibition Center (BEC) which covers an area of more than 250,000 square meters. The center is one of the landmarks of the Basque country and situated just outside of Bilbabo in Barakaldo.

ImagineNano conference intends to gather the global nanotechnology community including researchers, investors, and policymakers. It focuses on the following four goals:

- Exhibiting the latest trends in micro and nanotechnologies
- Foster effective networking within nanotechnology
- Get to know key R&D players offering their capacities
- Matching organizations offering or seeking solutions

ImagineNano is an umbrella conference meaning that it itself consists of several smaller conferences focusing on different aspects of nanotechnology. The 2015 edition consisted of 5 international conferences and an industrial forum (see Appendix A for complete program):

• Graphene 2015

Covers the latest scientific achievements and research results on the fabrication, characterization, and application of graphene.

• NanoSpain 2015 – Chemistry

NanoSpain Chemistry covers the latest research achievements and the exciting opportunities in the field of Nanochemistry. In just 2 days, participants will get a complete overview into the state of the art of the exciting areas of chemical science and technology.

• NanoSpain 2015 - Bio&Med

The NanoSpain Bio&Med presents the most recent international developments in the field of Nanobiotechnology and Nanomedicine and provides a platform for multidisciplinary communication, new cooperation and projects to participants from both science and industry.

• NanoSpain 2015 – Toxicology

The NanoSpain Toxicology 2015 "Environmental, health and societal implications of the development and use of nanotechnology" aims to bring together academic scientists, researchers and industry to exchange and share their experiences and research results on the interactions between nanomaterials and biological systems. The issue of toxicological and Eco-toxicological risks of the use of nanotechnology in diverse contexts is a great challenge and will be discussed within the conference.

• PPM 2015 (Photonics/Plasmonics/Magneto-Optics)

PPM 2015 aim is to bring together top researchers and future leaders encouraging interactions between students, young speakers, and senior figures in the field. The topics will cover the experimental and theoretical aspects of light interaction with nanoscale objects and nanostructured materials, focusing on dielectric materials tailored on the nanoscale, metallic materials exploiting their capability to sustain Plasmon excitations, and magneto-optical materials that, on one side, allow external modification of the optical properties, and, on the other, are non-reciprocal permitting to envisage structures that are immune to backscattering.

• The Industrial Forum

The Industrial Forum brings together research managers and decision makers from industry and academia across all sectors. The goal of the Industrial Forum is to create a place where there is the possibility of exchanging knowledge, find partners and consequently make business.

About this report

This report is based on the information presented at the Industrial Forum and further discussions with the participants of this Forum. Additional information was collected during the poster sessions. Industrial forum consisted of five sessions among which the Graphene Commercialization session was the main event and hence the focus of this report. Please see Appendix B for the complete program of the Industrial Forum.

Graphene Market Update

The last year has been an eventful year for the graphene industry. The first round of commercial applications has already been announced, and the industry has witnessed intense investment and acquisition activity while further companies have gone public. Despite the high interest, the valuation of public graphene companies has been on the decline, returning largely to where they were at the time of their IPOs.

The graphene community continues to dream up a steady and divergent pipeline of long-term applications. Despite this, there is still a lack of the so-called 'killer application' and the suppliers are pursuing a subsection go-to-market strategy. However, today's commercial players have more realistic expectations, showing a convergence of focus on composite and energy storage applications and en-mass migration further downstream to offer intermediary products.

Latest mergers and acquisitions in Graphene industry

1. Grafoid acquires Alcerecco and Braille

Founded in 2011, Grafoid Inc. is a graphene research, development and Investment Company that invests in, manages, and develops markets for processes that produce economically scalable graphene for use in graphene development applications by leading corporations and institutions.



Grafoid's leading investment produces pristine, functional, high-energy density few layer graphene, utilizing a safe, non-destructive extraction process, leaving the lowest possible ecological footprint. The completely unique, proprietary process results in what Grafoid regards as a new global standard for economically scalable, high-purity graphene products — trademarked under the **MesoGraf**TM trade name — that can be tailored to both industrial and commercial applications.

ALCERECO is a technology company that develops and produces advanced materials, composites, alloys and coatings. The company's best known materials are aluminum-scandium alloys, specialty ceramics, rare earths and advanced composite materials.

ALCERECO caters for several markets, including aerospace, automotive, electronics, sporting goods, infrastructural and mining sectors. The company has a global customer base and production facilities that Grafoid says can be used to develop innovative, scalable processes to bring new **MesoGraf** graphene-based materials to market. It was announced recently that Grafoid is going to acquire ALCERECO for \$1.25 million CAD (about \$1.15 million USD). It seems that Grafoid acquired the company mainly for its facilities and and principals which can be used to help bring MesoGraf materials quicker to market. I guess they believe it will be easier to adopt the company's plant to graphene than to start from scratch.

Braille Battery is an American Company based in Sarasota, Florida that is the world leader in ultra-lightweight Lithium-Ion high performance batteries and also distributes and sells the world's first and only AGM carbon fiber race batteries.

Braille Battery becomes a subsidiary of Grafoid Inc., a complete graphene solutions company advancing the commercialization of $MesoGraf^{TM}$ graphene battery applications and products for the automotive, medical, military, and marine sectors.

2. Samsung invests in XG Sciences

XG Sciences, Inc. announced recently it has closed on a strategic investment led by Samsung Ventures Investment Corporation (Samsung Ventures). Philip Rose, XG Sciences CEO, said the investment will be used to fund additional research and development of the company's advanced materials. XG Sciences manufactures energy storage materials based on the company's



xGnP[®] graphene nanoplatelets and **XG Leaf**TM graphene sheet products. XG Sciences Inc. is a leading supplier of graphene nanoplatelets and custom, graphene-based products to global corporations serving energy storage, aerospace, automotive, industrial and consumer markets. In addition to its electrode materials, XG Sciences makes thermal management materials, and electrically and thermally conductive inks, coatings and adhesives based on its graphene nanoplatelets.

3. Repsol Energy invests in Graphenea (€1 million)

The investment is structured as a capital increase that reinforces Graphenea's equity and capability to lead the emerging graphene production industry. The funds will be used to accelerate its business plan towards industrialization. Graphenea is a leading startup in the emerging graphene production market. The company produces graphene films by Chemical Vapor



Deposition and graphene powders by Chemical Exfoliation technologies developed by the company. Materials produced by Graphenea are used for the development of batteries, supercapacitors, solar cells and thermal management materials just to mention a few energy related applications. Graphene materials are also used as polymer additives and advanced composites. Graphenea has developed a very competitive, scalable and environmentally-friendly production process.

Repsol is an integrated global energy company with vast sector experience. It carries out Upstream and Downstream activities throughout the entire world and employs more than 23,000 people. The main aim of the New Energy unit is to identify opportunities, promote projects and carry out business initiatives in spheres such as biofuels, renewable generation and sustainable mobility.

4. Versarien Plc acquires 2-DTech

Versarien plc, the advanced engineering materials group, has announced that it has entered into an agreement to acquire 85% of the issued share capital of 2-DTech from The University of Manchester. 2-DTech specializes in the supply, characterization and early stage development of graphene products. The total consideration for the Acquisition is £440,000. As a graphene partner,



the companies will work alongside to identify potential graphene applications.

5. FutureCarbon IP acquisition from Bayer Material science

FutureCarbon GmbH takes on substantial intellectual property from Bayer Material Science related to Carbon Nanotube (CNT) and Graphene. The two parties have now signed an agreement to the effect of Future Carbon acquiring the bulk of Bayer's corresponding patents regarding carbon nanotubes and graphene.



FutureCarbon specializes in the development and manufacture of carbon nanomaterials and their refinement to create what are called carbon supercomposites, primary products for further industrial processing. Carbon supercomposites are combinations of materials that unfold the special characteristics of carbon nano-materials in the macroscopic world of real applications. All of their materials are manufactured on an industrial scale.

6. Directa PLUS collaborates with Vittoria

Directa Plus owns two production technologies, which are covered by proprietary trade secrets and patented intellectual property:

G+ *technology*: leads to products based on pristine graphene nanoplatelets with its specific technical characteristics.

D+ technology: leads to nanoscale metal



particles and nanoalloys, for applications in the field of catalysts, utilizing versatile raw materials such as metal carbonyls.

The Directa Plus G+ technology is a continuous, simple, scalable, and low cost manufacturing process for the production of graphene based materials. The chemical intercalation of natural graphite followed by thermal plasma expansion represents the basis of G+ technology. Directa Plus produces 6 families of graphene based materials:

- **Basic G+**: Super-expanded, accordion-like graphite products.
- Ultra G+: Very fine powders of super-expanded graphite
- Liquid G+: Water-based dispersions of pristine graphene nanoparticles.

- **Pure G+**: Extremely fine nanopowders of pristine graphene nanoplatelets.
- Zappa G+: Masterbatchs of pristine graphene nanoplatelets.
- **Paste G+**: H ighly concentrated water-based paste of pristine graphene nanoparticles.

The Italian branch of Vittoria Industries Ltd. – the world's leading manufacturer of bicycle tires, has developed, together with Directa Plus, a practical and scalable method for adding **G**+ **graphene-based material**, to rubber for bicycle tires and also to carbon-fiber products like wheels. In September 2014 Vittoria and Directa presented the fastest bicycle wheel in the world, **Qurano**, containing G+ inside the carbon-fiber rim.

Chinese firms ramping up graphene production

Many Chinese firms presented their latest achievements in producing large quantities of graphene and related materials. The production scale is ramping up fast and includes both topdown approach (graphite pathway) as well as the bottom up approach (synthesis pathway). The following table summarizes the Chinese companies with considerable graphene production.

Company	Material	Capacity
Ningbo MORSH	GNP	300 tpa
Deyang Carbonene	GNP	1.5 tpa
KNANO	rGO	50 tpa
XFNANO	rGO	3.6 tpa
WUXI Graphene Film	CVD film	250 000 sqm
2D Carbon Graphene	CVD film	150 000 sqm
The Sixth Element	GNP/rGO	100 tpa

Graphene market size in the next 10 years

IDTechEx is an independent market research firm providing insight into markets and technologies. IDTechEx has performed extensive market analysis for graphene industry and has predicted the market size in the next 10 years in the following chart.



Energy Applications

Graphene enhanced batteries

One of the main application branches that has received considerable attention from the industry is the use of graphene for energy storage. A number of companies and research institutes have already demonstrated the use of graphene in achieving batteries with superior performance:

1. Berkley Lab:

A graphene modified Li sulphur battery has been demonstrated by researchers at Berkley Lab achieving twice the Wh/Kg of common Li-ion battery with demonstrated charge-discharge cycles of more than 1,500. The cathode in this battery is composed of sulphur-graphene oxide (S-GO), a material developed by the team that can accommodate the volume change of the electrode active material as sulphur is converted



to Li2S on discharge, and back to elemental sulphur on recharge.

2. OXIS Energy:

OXIS Energy is developing an innovative Lithium Sulfur battery chemistry with a claimed theoretical energy density 5 times greater than Li-ion. According to OXIS Energy their patented Li-S technology is lighter, safer and maintenance free. OXIS's next generation lithium technology platform offers the highest energy



density among lithium chemistry: 300 Wh/kg achieved at cell level in 2014. Their forecast for 2016 is 400 Wh/kg. In collaboration with Perpetuus Carbon Group, OXIS Energy is developing graphene-enabled electrodes for their next generation (Li-S)

battery technology. Using its proprietary plasma technology, Perpetuus is able to insert molecules into layered solids such as graphite (known as intercalation) to the very high levels required for enriched electrode materials.

3. Graphene NanoChem:

Graphene NanoChem and Sync R&D will partner to contribute resources to develop and integrate a graphene-enhanced Li-ion Battery into a prototype electric shuttle bus in Malaysia designed and developed by Sync R&D, with Graphene NanoChem taking the lead role in the applications development activities to design and produce the graphene-enhanced lithium-ion battery. A graphene-enhanced anode, a component in the Li-on Battery, has been proven to provide 10 times more power storage and significantly reduces the time required to recharge the battery. Graphene NanoChem will work to develop further the Li-on Battery technology, with the primary aims of increased durability and enhancing further the storage capability, giving increased distances travelled before requiring recharge. The first prototype of the grapheneenhanced Li-on Battery is expected to be completed in 2016.

4. XG Sciences:

XG Sciences has launched its offering, which features a graphene-hybrid material for use in the anodes of Li-ion batteries. The company claims that the anodes will result in Li-ion batteries that have four times the capacity of today's conventional anode batteries. The basis of the anodes is a material the company has dubbed **xGnP**. The material uses graphene nanoplatelets that stabilize silicon particles into a nanostructured silicon. Nanostructured silicon anodes have become an attractive alternative to graphite-based anodes, which have a relatively small charge capacity, and silicon, which by itself starts to crack and fall apart after just a few charge/discharge cycles. XG Sciences believes that the new Silicon-graphene anode material, when used in combination with the existing xGnP® graphene products as conductive additives, provides significantly higher energy storage than conventional battery materials.

5. Vorbeck:

Vorbeck has developed a strong IP portfolio on the use of graphene in Li batteries. It is focusing on sulphur batteries. Through their Vor-x® graphene product line they aim

at expanding the limit of energy storage technology with lithium sulphur batteries and flexible battery straps.

6. Cabot:

Cabot Corporation is a leading global specialty chemicals and performance materials company headquartered in Boston, Massachusetts, USA. They are developing graphene and graphene related products for a number of applications. They have recently announced a graphene additive product for the Li ion battery business. The product (LITXTM G700) is mainly a conductive additive enabling better performance leading to longer run times for electric vehicles.

Other energy related applications

GDF SUEZ is a global energy player and an expert operator in the three key sectors of electricity, natural gas and energy services. At the Industrial Forum Dr. Laurent Baraton gave a presentation summarizing the activities at GDF SUEZ concerning the application of graphene in different energy-related field. Although no detailed information was given about each topic but activity areas were as follows:

- Using graphene as transparent conductive layer for PV applications
- Graphene for efficient water purification
- Graphene for gas purification and gas separation
- Graphene based catalysts for fuel cell applications
- Battery and super capacitor applications
- Graphene-polymer oil pumps for better durability
- Adding graphene in metal pipes for enhancing the welding properties of the pipe.
- Graphene application for heatsinks in demanding applications.

Performance of graphene materials in energy storage applications from BASF

Dr. Shyam Venkataraman presented the Carbon Materials Innovation Center (CMIC) at BASF. At this center advanced carbon materials are being investigated for several potential fields of application such as electronics, catalysis, and energy storage and conversion devices. He presented recent results from their lab on using few layers graphene (FLG) in electrochemical capacitor and lithium ion battery applications. In electrochemical capacitor applications, FLG shows higher power density and lower energy density compared to the state of the art activated carbon. In lithium ion battery applications, addition of FLG materials to anode formulation containing silicon (Si) anode slurries leads to improvement in capacity fading. However, he concluded, the improvements achieved by graphene in above applications are not large enough to justify the considerable cost increase the use of graphene would imply at themoment.

Graphene fabrication and composite applications

During the conference and based on the information presented there, a number of companies were identified which have started to introduce graphene based composites to the market. These companies and their products are listed here.

High performance bicycle rims from Vittoria

Vittoria (an Italian company) has fabricated and started to market a graphene-enhanced fullcarbon race wheels for bicycles. They have enhanced their carbon bicycle rims with Graphene G+ product line from Directa PLUS. They claim that the addition of the G+ results in a faster, stronger, more resilient carbon-composite material. **Qurano 46**, which is the name of the new product, has graphene-enhanced full-carbon rims that far outperform today's best. Grapheneenhanced composites have 10~30% improved material properties. Tests carried out by Vittoria R&D engineers, confirmed by external laboratories found that introducing graphene into the rim's carbon-fiber matrix has a great positive impact:

- G+ reduces temperature build-up
- G+ increases spoke-hole strength measurably
- G+ significantly improves lateral stiffness
- G+ has strong potential for a future product weight reduction

Graphene enhanced polymers by PolyMat

POLYMAT is a research institute that provides support to industry through a multidisciplinary research program in the field of polymers. Dr. Antxon Santamaría gave a presentation on the recent results achieved by mixing graphene with different polymers. Polymat uses a technique called **Melt Mixing** (masterbatch dilution method) to combine graphene with polymers. This process was originally developed to disperse carbon nanotubes

into thermoplastic polymers. The application areas for the enhanced polymers developed in this way was is categorized in three groups:

- Electrostatic dissipation. This application area requires conductivity in the range of 10⁻⁹ S/m.
- Electrostatic paints. This area requires a conductivity of the range of 10^{-6} S/m.
- EMI shielding which requires conductivity in the range of 10^{-1} S/m.

Graphene enhanced paints by Graphene Stone

Graphene Stone is a company located in Spain which produces and markets graphene containing paints. According to the company the new product is an ecological coating that contains graphene of low density combined with natural materials that controls the pollutant agents and can be used both for interiors and exteriors. It was emphasized that the new product can cover larger areas per one liter of paint and has a superior permanence compared to other paints. Moreover, their tests have shown that the new paint has a better performancein absorbing sounds.

Graphene production by Applied Graphene Materials

Applied Graphene Materials (AGM) was founded by Professor Karl Coleman in 2010, with its operations and processes based on technology that he initially developed at Durham University. Applied Graphene Materials has developed a proprietary "bottom up" process for the production of high specification graphene. The process is based on using Ethanol as the precursor. The catalyst mixed with ethanol is introduced to a high temperature reactor where graphene is synthesized. The airborne graphene flakes are collected in the wetted state in a collector in order to reduce the risk of inhalation. The result is a loosely stacked graphene flakes which disperses very. They believe that such a bottom-up approach has four key advantages over the common graphene fabrication method which uses graphite as the starting material:

- The process is not dependent on Graphite (strategic reasons)
- The fabrication process is continuous
- The produced graphene is free from graphitic impurities which is common in the topdown approach

• The resulted graphene is easy to disperse

The primary application areas that AGM focuses on are paints additive, coating, and lubricants.

Graphene CVD tools from Aixtron

Dr. Ken Teo presented the CVD equipment from Aixtron which targets industrial scale graphene CVD growth on wafers up to 300 mm. the new synthesis tools are sold under the name of BM300 and BM300T. The new tools feature:

- 1050° C substrate heater
- Uniform gas delivery through showerhead
- Precise precursor concentration control
- Heater to showerhead gap adjust
- Wafer rotation during process
- ARGUS real-time wafer temperature mapping
- Optical ports at normal incidence to wafer

Graphene characterization

Tip enhanced Raman by HORIBA Scientific

HORIBA Scientific located in Grenoble, France offerings encompasses elemental analysis, fluorescence, forensics, GDS, ICP, particle characterization, Raman, spectral ellipsometry, sulfur-in-oil, water quality, and XRF.

HRIBA Scientific is developing systems which focus on Tip Enhanced Raman Spectroscopy. In this method the accurate information collected through a scanning Tunneling tip (Topography + Mechanical + Chemical Signature) is combined with the data from Raman spectroscopy. This is sold as a product that can be very useful for fast analysis of samples containing CNT and graphene. The product called **XPLORA NANO**. Information such as number of layer and mechanical shape of the graphene layers can be detected in fast and accurate way.

SIMUNE Atomic Simulations

SIMUNE offers customized services in the field of atomic scale simulations. Their approach has direct application on the development of advanced materials with high technological needs, with special focus on atomic-scale simulations. The identification of new materials with specific properties and the design of new functional materials are examples of the areas where SIMUNE has much to offer. This can lead to specific solutions in various sectors such as energy, electronics, and transport.

They presented their approach on simulating graphene based micro-electromechanical systems (MEMS).

Appendix A: ImagineNano 2015 Program

IMAGINENANO PLENARY SESSION			
		Tuesday - March 10, 2015	
08:00-09:00	Registration		
09:00-09:20	Imaginenano20	15 Opening Ceremony - Welcome and Introduction	
09:20-09:35	Israel presentat	ion – Invited country (Alon Bar (Israel Embassador) & Nava Swersky)	
09:35-11:15	Tribute to Heini Rohrer		
	09:35-09:45	Pedro Miguel Echenique (DIPC, Spain) Welcome and Introduction	
	•	Chairman: Pedro Miguel Echenique (DIPC, Spain)	
	09:45-10:30	Ignacio Cirac (Max Planck Institute of Quantum Optics, Germany) Quantum simulations with atoms in nano-structures	(PL)
	10:30-11:15	Jean-Marie Lehn (University of Strasbourg, France) The self-organization approach	(PL)
11:15-12:00		Poster Session - Coffee Break	

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Tuesday - March 10, 2015	

	Chairman: Jean-Christophe Charlier (University of Louvain, Belgium)		
12:00-12:40	Pulickel Ajayan (Rice University, USA) Materials Science of Two Dimensional Atomic Layers	(К)	
12:40-12:55	Catherine Journet (University Lyon 1, France) Synthesis of self-standing highly crystallized hexagonal boron nitride (h-BN)	(0)	
12:55-13:10	Zhang Yanfeng (Peking university, China) Growth and atomic-scale characterization of graphene-h-BN hybrids on single crystal substrates	(0)	
13:10-13:25	Hyeon Jin Shin (Samsung Advanced Institute of Technology, Korea) Growth Mechanism of Hexagonal Boron Nitride: by Nanocrystalline Graphene Assistance and/or by B-N molecular diffusion	(0)	
13:25-13:40	Michael Hilke (McGill University & FU Berlin, Canada) Graphene Growth Dynamics and Phonon Engineering using Isotopes	(0)	
13:40-15:00	Cocktail Lunch offered by the organisation & Poster Session Reception offered by the Israeli Embassy (13:30)		
	Chairman: Stephan Roche (ICN2, Spain)		
15:00-15:40	Antonio H. Castro Neto (National University of Singapore, Singapore) From Graphene to Phospherene: the 2D zoo	(К)	
15:40-16:10	Wang Yao (HKU, Hong Kong) Valley and spin currents in 2D transition metal dichalcogenides	(I)	
16:10-16:25	Stefano Dal Conte (IFN-CNR and Politecnico di Milano, Italy) Disentangling spin and valley dynamics in monolayer MoS2 by non-equilibrium optical techniques	(0)	
16:25-16:55	Frank Koppens (ICFO, Spain) Photodetection and nano-photonics of graphene and heterostructures of 2d materials	(I)	

16:55-17:45	Coffee Break - Poster Session			
	Chairman: Wang Yao (HKU, Hong Kong)			
17:45-18:15	Andras Kis (EPFL, Switzerland) MoS2 and dichalcogenide based devices and hybrid heterostructures	(I)		
18:15-18:30	Elena del Corro (J. Heyrovsky Institute of Physical Chemistry of the ASCR, v.v.i., Czech Republic) Single Layer MoS2 under Direct Compression: Low Pressure Band-gap Engineering	(0)		
18:30-18:45	Guy Le Lay (Aix-Marseille University, France) From single to multilayer germanene	(0)		
18:45-19:00	Evangelia Xenogiannopoulou (Institute of Nanoscience and Nanotechnology, National Center for Scientific Research 'DEMOKRITOS', Greece) Evidence for epitaxial germanene formation on AIN(0001)/Ag(111) template	(0)		

	TENTATIVE PROGRAM 2015		
	Wednesday - March 11, 2015		
	Chairman: Andras Kis (EPFL, Switzerland)		
09:00-09:30	Alberto Morpurgo (University of Geneva, Switzerland) New phenomena in transport through suspended graphene devices	(I)	
09:30-09:45	John Wallbank (Lancaster University, United Kingdom) Twist-controlled resonant tunnelling in graphene/boron-nitride/graphene heterostructures	(0)	
09:45-10:00	Adrian Balan (CEA -Licsen, France) The effect of defects produced by electron irradiation on the electrical properties of graphene and MoS2	(0)	
10:00-10:15	Jens Baringhaus (Leibniz Universität, Institut für Festkörperphysik, Germany) Exceptional ballistic transport in self-assembled sidewall graphene nanoribbons	(0)	

10:15-10:30	Enrique Diez (Universidad de Salamanca, Spain) Antiferromagnetic to Ferromagnetic phase transition in bilayer graphene	(0)
10:30-11:00	Barbaros Ozyilmaz (NUS, Singapore) Transport Studies in Black Phosphorus Field Effect Transistors	(I)
11:00-11:30	Coffee Break - Poster Session	
	Parallel Workshop 1: Applications of Graphene-based Materials - More info	
	Parallel Workshop 2: Materials & Devices Characterization - More info	
	Parallel Workshop 3: Theory & Simulation - <u>More info</u>	
	Parallel Workshop 5: Standardization - <u>More info</u>	
13:45-15:00	Lunch	
	Parallel Workshop 1: Applications of Graphene-based Materials- More info	
	Parallel Workshop 2: Materials & Devices Characterization- More info	
	Parallel Workshop 3: Theory & Simulation- <u>More info</u>	
	Parallel Workshop 4: Worldwide Graphene Initiatives - <u>More info</u>	

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Thursday - March 12, 2015		
09:00-11:15	Parallel Workshop PhD Students: Track A - <u>More info</u>	
09:00-11:15	Parallel Workshop PhD Students: Track B - <u>More info</u>	
09:00-11:15	Parallel Workshop PhD Students: Track C - <u>More info</u>	
11:15-13:00	Coffee Break - Poster Session	
13:00-15:00	Cocktail Lunch	
Chairman: Luigi Colombo (Texas Instruments, USA)		
15:00-15:40	Young Hee Lee (SKKU, South Korea) Towards large-area monocrystalline graphene:Synthesis and applications	(К)
15:40-15:55	Yu Chen (East China University of Science and Technology, China) Polymer Covalently Modified Graphene for Nonvolatile Rewritable Memory	(0)
15:55-16:10	Nicolas Decorde (Cambridge Graphene Center, United Kingdom) 3d printing of graphene-polymer composites	(0)
16:10-16:25	Vladimir Ermolov (VTT, Finland) Opportunities and challenges of graphene application in passive micro- and millimetre wave components	(0)
16:25-17:30	Coffee Break - Poster Session	
Chairman: Francesco Bonaccorso (ITT, Italy)		
17:30-18:00	Jun Lou (Rice University, USA) Synthesis, Characterization and Engineering of Two-Dimensional Materials	(I)

18:00-18:15	Oleksandr Ivasenko (KU Leuven- University of Leuven, Belgium) Morphology and nano-manipulation of covalently grafted layers on graphene and graphitic substrates: a step towards graphene-based integrated circuits	(0)
18:15-18:30	Jérôme Lagoute (MPQ, Université Paris Diderot, France) Nitrogen doping of graphene studied by scanning tunneling microscopy	(0)
18:30-19:00	Andrea C. Ferrari (Cambridge Graphene Centre, UK) The European roadmap for science and technology of graphene and related materials	(I)

	TENTATIVE PROGRAM 2015		
	Friday - March 13, 2015		
	Chairman: Aleksandr Rodin (Boston University, USA)		
09:00-09:30	Deji Akinwande (University Texas at Austin, USA) Flexible Black Phosphorus Transistors: Materials, Devices, and Radio Circuits	(I)	
09:30-09:45	Marcos Pimenta (UFMG, Brazil) Excitonic transitions in 2D transition metal dichalcogenides (MoS2, WS2 and WSe2) observed by resonance Raman spectroscopy	(O)	
09:45-10:00	Jean-Louis Sauvajol (CNRS-University Montpellier 2, France) Combined Raman spectroscopy and reflection/transmission measurements for graphene characterization	(O)	
10:00-10:15	Jiong Zhao (SungKyunKwan Univerisity, Korea) In situ Transmission Electron Microscopy for Nanoscale Dynamics and Properties of 2D materials	(O)	
10:15-10:30	Zhenhua Ni (Southeast University, China) Defect modulated photoresponse and thermal conductivity in graphene	(O)	
10:30-11:30	Coffee Break - Poster Session		

Chairman: Deji Akinwande (University Texas at Austin, USA)		
11:30-12:00	Max Lemme (University of Siegen, Germany) High Sensitivity of Graphene-based Sensors – Opportunities and Limitations	(I)
12:00-12:15	Madeline Diaz-Serrano (University of Pennsylvania, United States) High Yield and Scalable Fabrication of Nano/Bio Hybrid Graphene Field Effect Transistors for Cancer Biomarker Detection	(O)
12:15-12:30	Maria Cristina dos Santos (Universidade de São Paulo, Brazil) Large-Area Si-Doped Graphene: Controllable Synthesis and Enhanced Molecular Sensing	(0)
12:30-12:45	Omur Isil Aydin (IMEP-LAHC, France) Robust fabrication of suspended structures from CVD graphene	(0)
12:45-13:15	Jose A. Garrido (TU München, Germany) Graphene-based electronics for biomedical applications	(I)
13:15-14:45	Lunch	
	Chairman: Luis Foa-Torres (UNC, Argentina)	
14:45-15:15	Luigi Colombo (Texas Instruments, USA) 2D Materials Growth: Prospects and Challenges	(I)
15:15-15:30	Pablo Alonso-González (CIC nanoGUNE, Spain) Two Dimensional Nanooptics with Graphene Plasmons	(0)
15:30-15:45	Hyo Won Kim (Samsung Advanced Institute of Technology, Korea) Strong Interaction between Graphene Edge and Metal Revealed by Scanning Tunneling Microscopy	(0)
15:45-16:00	Wilfrid Poirier (Laboratoire National de métrologie et d'Essais, France) User-friendly graphene-based quantum resistance standards	(0)
16:00-16:15	Cristina Gomez-Navarro (Universidad Autonoma de Madrid, Spain) Stiffening graphene by controlled defect creation	(0)

16:15-16:30	Ling Hao (National Physical Laboratory, United Kingdom) Graphene drum mechanical resonators detected by microwaves	(0)
16:30-17:00	Taiichi Otsuji (Tohoku University, Japan) Recent advances in graphene heterostructures toward the creation of terahertz lasers	(I)
17:00	Concluding Remarks	

Appendix B: Industrial Forum Program

Wednesday - March 11, 2015			
	NANOMATERIALS		
09.00-09.12	Guillermo Antorrena Pardo (INA/LMA - Universidad de Zaragoza, Spain)	(0)	
	Advanced Microscopy Services for Industrial Applications	•	
09:15-09:30	David Talavera (CTECHnano, Spain)	(0)	
	CTECHnano. Innovating with ALD solutions		
09:30-09:45	Ander de Bustos (Simune, Spain)	(O)	
00.00 00.40	SIMUNE ATOMISTICS	1	
09:45-10:00	Marc Chaigneau (HORIBA, France)	(O)	
00.10 10.00	Tip Enhanced Raman (TERS) imaging: fast imaging of carbon-based nanomaterials	1	
10.00-10.15	Ido Winer (Tortech Nano Fibers, Israel)	(0)	
10.00 10.10	Tortech Nano Fibers - Non-woven mats made of ultra-long carbon nanotubes for advanced applications	1	
	Begoña Galindo (AIMPLAS, Spain)	(0)	
10:15-10:30	Microwave heating of polymers: influence of carbon nanostructures dispersion on the microwave susceptor effectiveness		
10:30-10:45	Pilar de Miguel (CDTI, Spain)	(0)	

	CDTI Funding Opportunities	
10:45-11:00	Andres Ubierna (INNVIERTE, Spain)	(0)
	Venture Capital for Technology and Innovative SMES in Spain	
	Graphenea, PRAXIS PHARMACEUTICAL	(0)
11.00 11.00	Case studies	
11:30-12:00	Coffee Break	
	NANOCOMPOSITES	
12:00-12:15	Antxon Santamaría (Polymat)	(0)
12.00-12.15	Polymers which contain conductive nanoparticles: challenges and hopes for novel (industrial) applications	
12:15-12:30	Bartolomé Simonet (Carbures)	(0)
12.10-12.00	Nanocomposites and the Automotive Sector	
12:30-12:45	Antonio León (IEDISA)	(0)
12.30-12.45	New generation of ecopaints containing graphene	
12:45-13:00	Sonia Florez (TECNALIA)	(0)
12.40-13.00	PLATFORM (H2020): Industrialization of nano-enabled products to be introduced in common composite processes	
13:00-13:15	POLIFLUOR	(0)
13.00-13.15	Thermoplastic nanocomposites	
13:15-13:30	Debate	
13:30-15:00	Lunch	

	Tech Transfer & Opportunities for International Cooperation	
The third session will in In the same t	of the Industrial Forum, organized by Phantoms Foundation will affect the transfer of nanotechnology in various industrial volve different speakers from countries where the transfer of nanotechnology is considered a success as Israel or Ireland. ransfer activity developed in the Basque Country through the spin-off of CIC nanoGUNE C-technano and SIMUNE will be	sectors. It shown
	Chairman: Javier Maira (CSIC, Spain)	
15:00-15:30	Nava Swersky Sofer (ICA, Israel)	(К)
	To be defined	
15:20 15:45	Dana Gavish-Fridman (Yissum, Israel)	(0)
	From basic research to the commercial arena at the Hebrew University of Jerusalem	
15:45-16:15	Victor Acinas (CCAN, Ireland)	(K)
	Collaboration - an essential ingredient for nanotech commercialization	
16:15-16:30	Laura Toledo (Fundación Argentina de Nanotecnología, Argentina)	(0)
	Building pillars for NanoTech-transfer in Argentina: networking for acceleration	
16:30-16:45	Yolanda de Miguel (TECNALIA, Spain)	(0)
10.00 10.40	Nanotechnology Cluster at TECNALIA	
16:45-17:00	Jiri Fusek (Czech Invest, Czech Republic)	(0)
	Nanotechnology & Tech Transfer in the Czech Republic – Recent Developments	
17:00-17:30	Coffee Break	
	Chairman: Yolanda de Miguel (TECNALIA, Spain)	
17:30-18:00	Consuelo Espejo Rodriguez (OEPM, Spain)	(K)

	The role of IP in the technology transfer process	
18:00-18:30	Javier Maira (CSIC, Spain)	(K)
	Technology Transfer in the area of nanotechnology: licenses agreements and Spin-off companies	

Thursday - March 12, 2015		
GRAPHENE COMMERCIALIZATION		
	Chairman: Laurent Baraton (GDF Suez, France)	
09:15-09:45	Khasha Ghaffarzadeh (IDTechEx, UK)	(I)
	Graphene- markets, applications and the latest commercialisation progress	*
09:45-10:15	Ania Servant (NGI-University of Manchester, UK)	(I)
	The route to graphene commercialisation	
10:15-10:45	Chun-Yun Sung (Lockheed Martin, USA)	(I)
	Graphene and New 2D Materials: Industry Needs and Commercialization	
10:45-11:15	Karl S. Coleman (Durham University & Applied Graphene Materials, UK)	(I)
100-11.10	Synthetic Graphene	
11:15-12:00	Coffee Break	
Chairman: Karl S. Coleman (Durham University & Applied Graphene Materials, UK)		
12:00-12:30	Shyam Venkataraman (BASF, Germany)	(I)
	Performance of graphene materials in energy storage applications	
12:30-13:00	Laurent Baraton (GDF Suez, France)	(I)

	Graphene and 2D materials in the perspective of a global energy player	
13:00-15:00	Lunch	
	Chairman: Karlheinz Strobl (CVD Equipment Corporation, USA)	
15:00-15:30	Ken Teo (Aixtron, UK)	(I)
	Industry Perspective on Thin Film Graphene Growth	
15:30-16:00	Iñigo Charola (Graphenea, Spain)	(I)
	Advances in Technology Development for the Production and Applications of Graphene Materials	
16:00-16:30	Ashot Ter-Avanessov (OCSiAL Ltd., UK)	(I)
10.00 10.00	Single Wall Carbon Nanotubes Large Scale Production: Bridged the Gap From Lab Potential to Commercial Rea	lity
16:30-17:30	Coffee Break	
	Chairman: To be defined	
17:30-18:00	Karlheinz Strobl (CVD Equipment Corporation, USA)	(I)
	Graphene Innovations Drive Nano Material Manufacturing Technologies	
18:00-18:30	Kazuo Muramatsu (Incubation Alliance, Japan)	(I)
	Self-standing synthesis graphene on the carbon fiber surface	
18:30-18:45	Arnaldo Galbiati (SOLARIS PHOTONICS, United Kingdom)	(O)
	Large-area Graphene Production using Roll-to-roll (R2R) Technology	
18:45-19:00	Antonio Leon (IEDISA, Spain)	(0)
	New Generation of coatings with Graphene	