What is Graphene?

Graphite

- A special family of nanomaterials
- Common forms of carbon
- Diamond properties
  - Diamond is the hardest natural material known to man
  - Excellent electrical insulators

Diamond

Graphene
What is Graphene?

Graphite

Graphene
Graphene: discovery in 2004

The Nobel Prize in Physics 2010 was awarded jointly to Andre Geim and Konstantin Novoselov

"for groundbreaking experiments regarding the two-dimensional material graphene"
Graphene applications

- Medical applications: drug delivery; lab-on-chip; DNA sequencing
- Batteries; supercapacitors; conductive inks; etc.
- Graphene electronics
- Composites; barrier films
- MEMS; various sensors
- Ultra-high frequency electronics; optoelectronics
- Graphene derivatives; e.g., 2D analogue of Teflon
- Flexible LCD and LED wall lightning
Other Layered Materials

Materials on demand: designed & built with single atom precision
Graphene research: explosive growth since 2004

Published Items in Each Year

Equally distributed!

Patent Search

Not equally distributed: Action required!
Background and Timeline

2010, May: Present the idea of a Graphene Flagship in Brussels
2010, June: Compose a small consortium (9 partners) for the pilot project
2010, October: Submit pilot proposal
2011, Jan.: Six pilots approved. Pilots running May 1, 2011 – April 30, 2012
2011-2012: Prepare flagship proposal
- compose S&T roadmap
- determine work package structure
- compose initial consortium
2013, Jan.: Graphene and the Human Brain Project selected

**Negotiations with the EC**

2013, Oct 1: Project start with a 30 month ramp up phase
Ramp up phase: EC funding 54 M€ for 2.5 years; initially 18 M€/yr, after consortium expansion 23 M€/yr
After 2.5 years: EC funding 50 M€/yr plus national funding
Flagship goals

Scientific objectives

• **Material technologies for ICT and beyond**
  - Identify and explore new layered materials (LMs) and assess their scientific and technological potential.
  - Develop reliable, reproducible, sustainable and safe large scale production technologies for LMs.
  - Broaden the applications of graphene and other LMs beyond ICT

• **Component technologies**
  - Identify new device concepts enabled by graphene and LMs.
  - Develop component technologies that utilize the potential of these new materials platforms.

• **Systems integration**
  - Integrate graphene-based components to systems that provide new functionalities.
  - Integrate graphene and other LMs with existing technology platforms.

Operative targets

• Bring together a large core consortium of European academic and industrial partners.
• Create a highly effective technology transfer highway.
• Align the Flagship with European and national priorities (*ERA-NET)*.
• Engage the European societies with the Flagship.

Societal goals

• Contribute to sustainable development based on abundant, safe and recyclable natural resources.
• Boost economic growth in Europe by creating new jobs and investment opportunities.
Initial Flagship Consortium

75 partners (128 groups) from 17 countries, selected by WP leaders based on their contributions to Flagship goals

Universities, research centers, companies (e.g., Nokia, Airbus, Philips, Repsol, ST Micro-electronics, Alcatel Lucent, AMO GmbH, Graphenea, Aixtron, Oxford Instruments)
Present budget... (30 months)

Total project cost during 30 months is 75 M€, of which EC funds 54 M€.

On the right: distribution of total cost per S&T WP.

Note: Production is mostly funded through an NMP call.
Consortium expansion

- Open call, published Dec. 2013
  - Budget over 9 M€, focus on engineering
  - 11 technical topics specified, plus 1 bottom up topic, 700 k€/topic
  - E.g., standardization, chemical sensors, other layered materials, and engineering modeling have been proposed
  - Suggestions will be solicited from WP leaders, Strategic Advisory Council, Graphene Alliance (industrial) and national agencies, and decided by the Scientific Board
  - Received proposals will be evaluated and ranked by external, independent experts: *Flagship leadership cannot pick and choose new partners at will*
  - **EC rule**: existing beneficiaries are not eligible to apply (**PIC**)

- **ERA-NET**
  - Proposal submitted on April 16 by 22 national agencies (14 member states and 3 associated countries) plus 10 organizations that may join later (9 member states)
  - Multinational call(s) planned, maybe in 2015
  - The CP-CSA will work closely with the ERA-NET to create synergies
  - The ERA-NET proposal has not yet been evaluated and approved by the EC

- **Horizon 2020 expansion in 2016**
  - A flagship call with a closing date in 2015 will be published
  - EC contribution increases by a factor of 2-3, no details known about the national contributions
  - Expect that 150-200 partners will be included in the H2020 project
Graphene disruptive technologies - from European laboratories to Europeans