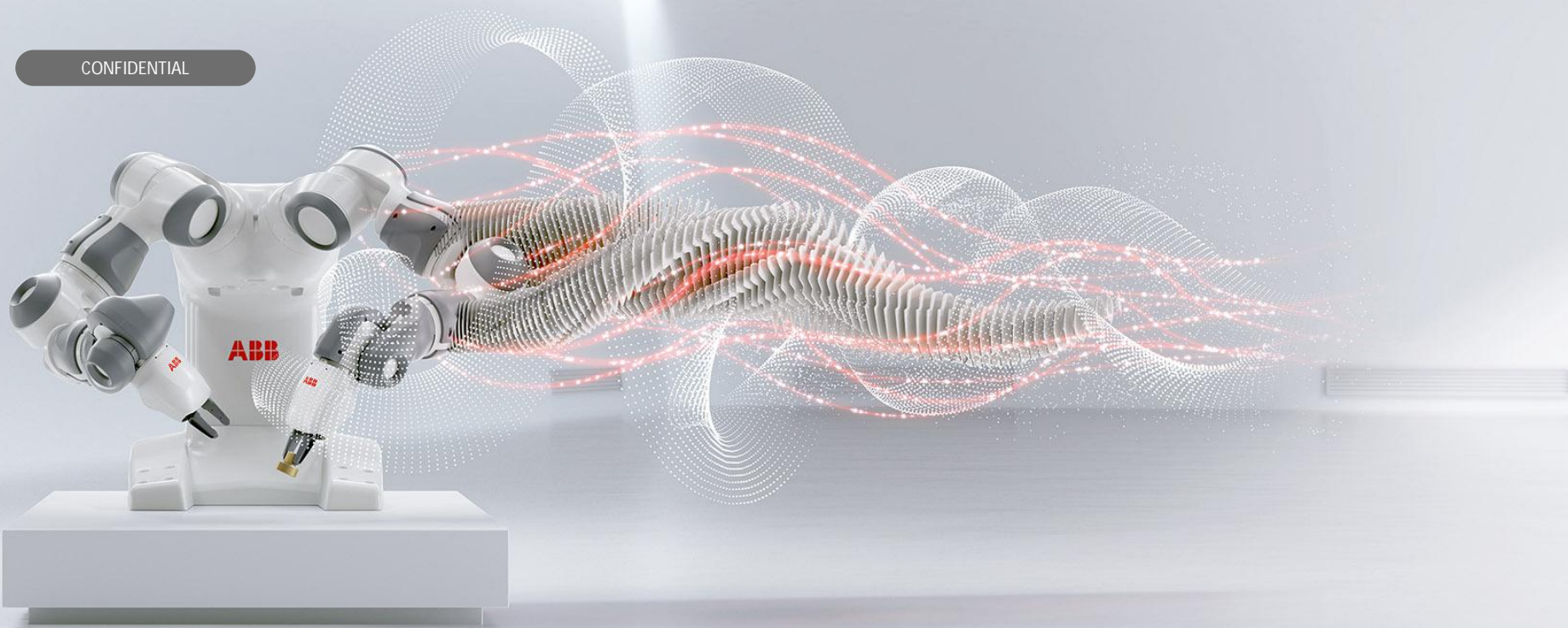


CONFIDENTIAL



FREDRIK SAHLÉN, ANNA ANDERSSON, ABB CORPORATE RESEARCH

Graphene

VBIK Ludvika 2018-05-14

ABB

Graphene

Tape dispenser at Nobel Museum in Stockholm



Agenda

- Graphene structure
- Graphene properties
- Graphene manufacturing
- Applications
- SiO Graphene
- Graphene Flagship
- ABB development

Nobel Prize in Physics 2010



Nobel Museum in Stockholm
Tape dispenser and a lump of graphite

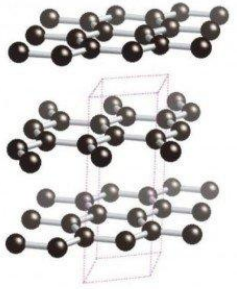


Konstantin Novoselov, Andre Geim
University of Manchester
Novel work in isolating graphene in 2004

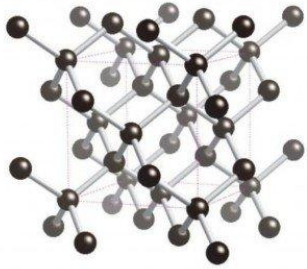


Nobel prize in physics 2010

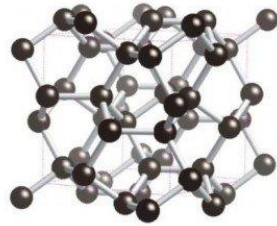
Alleotropes of carbon



graphite



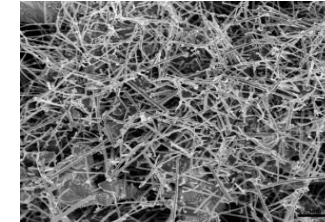
diamond



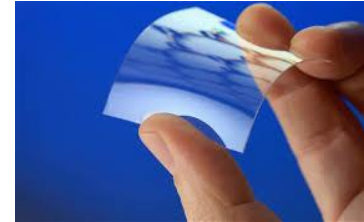
BC8



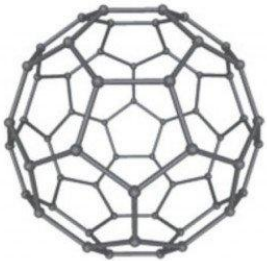
Diamond



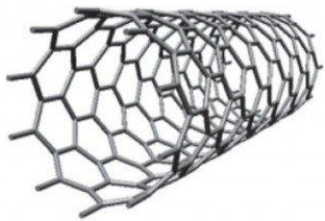
Carbon nanotubes (SEM)



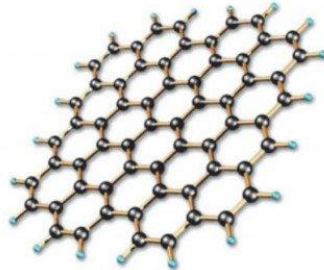
Graphene on plastic substrate



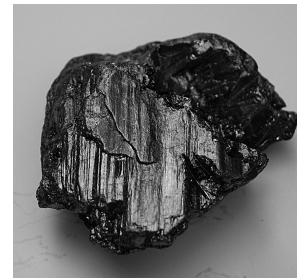
fullerene



nanotube



graphene

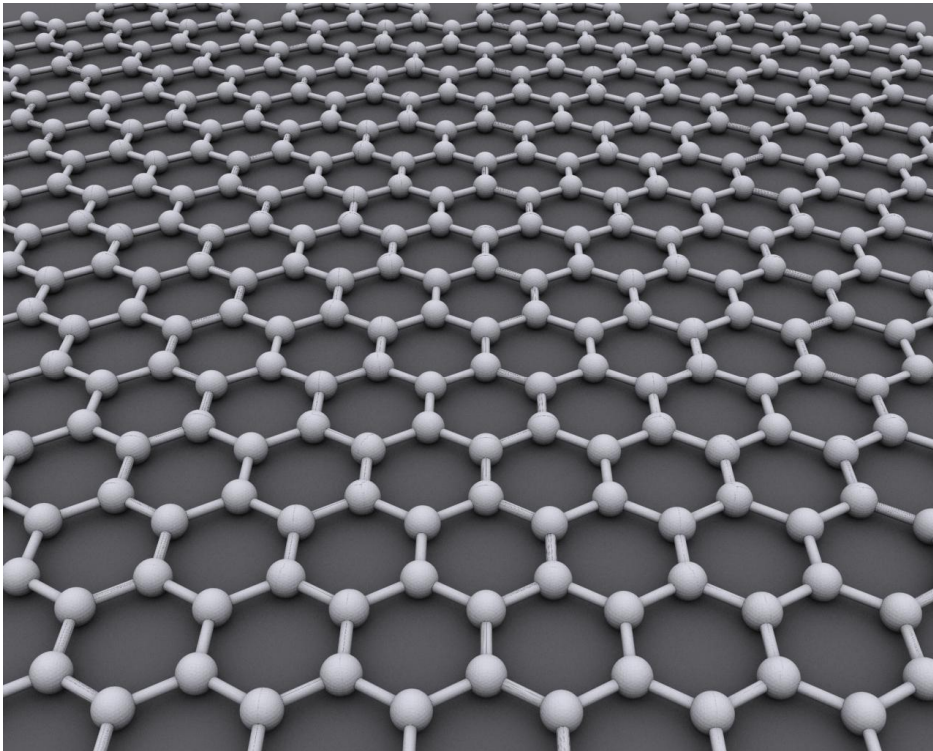


Graphite

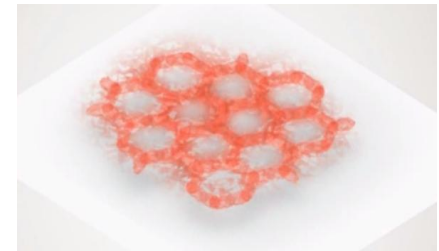
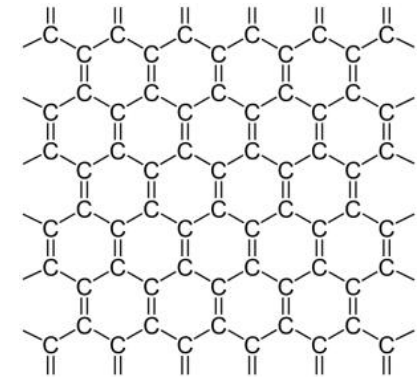
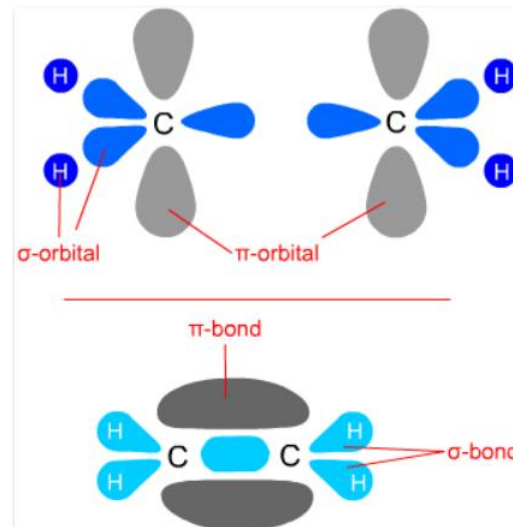


Amorphous soot, carbon black

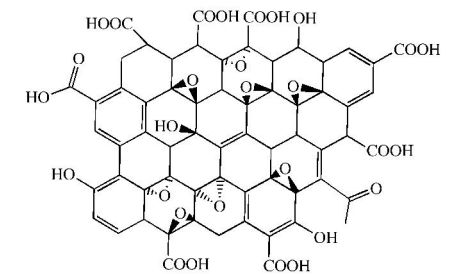
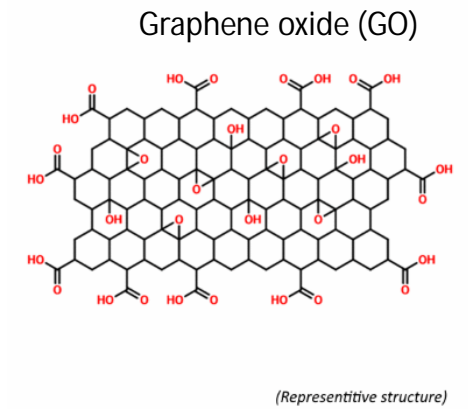
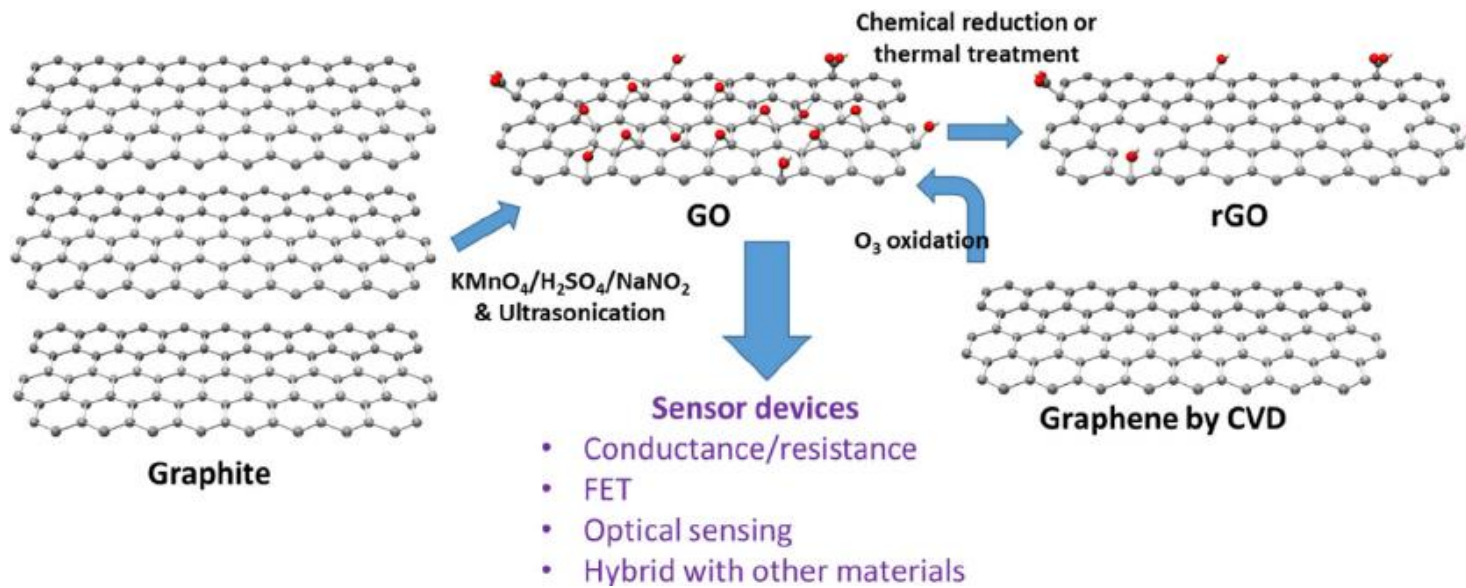
Bond structure



Carbon has 4 bond sites
3 sp^2 hybridized orbitals
1 p orbital



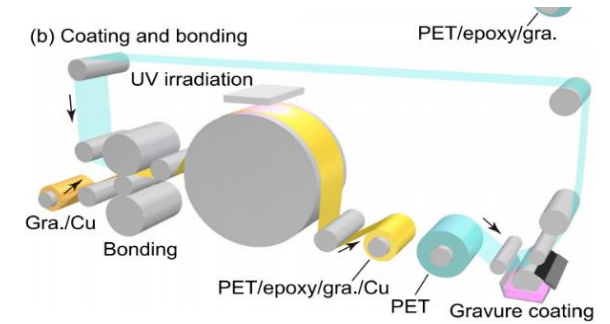
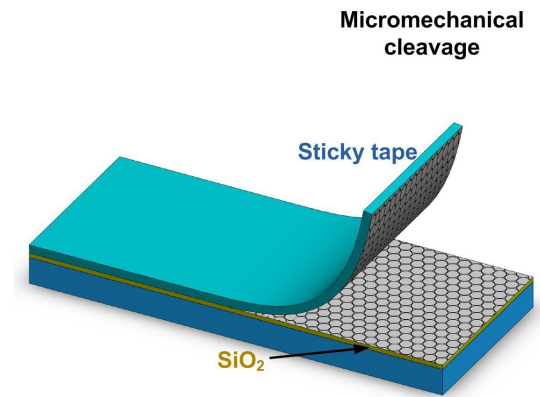
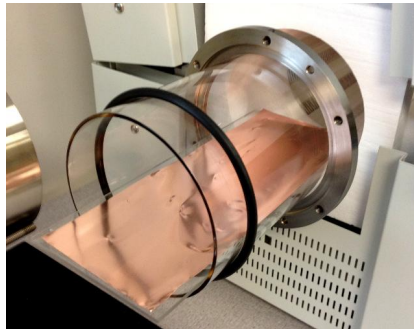
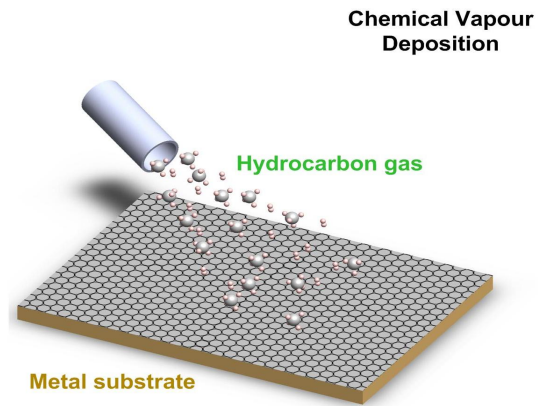
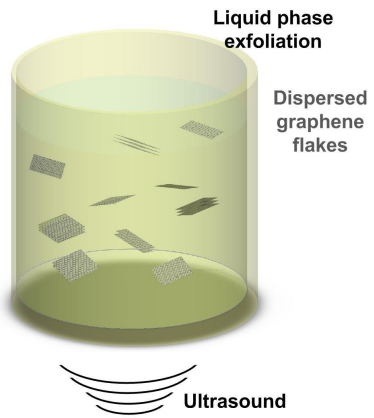
Graphene oxide, reduced graphene oxide



Properties

- Thinnest material– 1 one atom layer
- Strongest material
- Low weight
- Flexible
- Large surface area
- High thermal conductivity
- High electrical conductivity
- Transparent
- Good barrier properties
- Affinity to other molecules

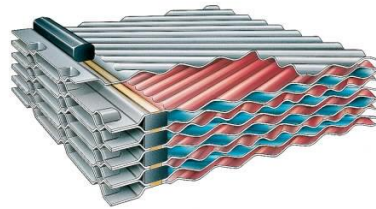
Manufacturing technologies



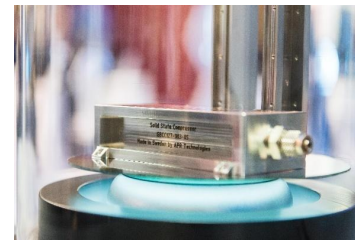
Applications



Hydrophobic surfaces
Barriers



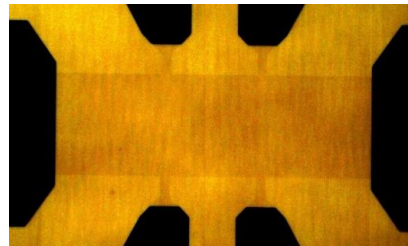
Corrosion protection



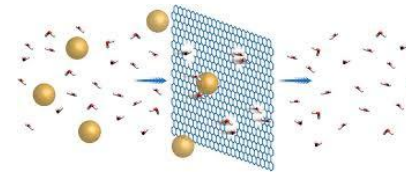
Miniaturized coolers



Multifunctional composites



Sensors, electronics



Filters

Products on the market

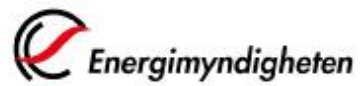
Composite materials





 **SIO GRAFEN**

Med stöd från:



STRATEGISKA
INNOVATIONS-
PROGRAM

*Sverige är ett av världens tio
främsta länder på att utnyttja
grafen för att säkerställa
industriellt ledarskap år 2030*





Mål

- Etablera grafen som industriellt styrkeområde
- Stärka samverkan
- Stimulera svenskt grafentillverkning
- Strategisk vägledning

Sensorer, tryckt elektronik,
högfrekvens elektronik



Materialtillverkning, karaktärisering,
processutveckling, testbäddar,
produktionsutveckling



Beläggningar,
membran,
barriärer, filter



Lagring, generering,
termisk och elektrisk ledning

Polymerbaserade med
och utan fiber, textilier,
betong, metall



Medicinteknik,
miljö- och hälsoaspekter



 SIO GRAFEN



Så här långt..

- 49 innovationsprojekt initierade
- > 60 organisationer har deltagit
- 31 SMF
- Produkter av 2D fab och Graphensic

Innovationsprojekt i Sverige

- Kylning av elektronik
- Smörjmedel
- Vattenrening
- Tryckt elektronik
- Gassensorer
- Förstärkning av cement och betong
- Barriärer i förpackningar
- Kamouflage
- Ytbeläggningar – antikorrosion, biofouling, nötning
- Ledande adhesiv
- Tillverkning av grafen och grafenbläck
- Multifunktionella kompositer och textilier



FET Flagships

“FET Flagships are ambitious large-scale, science-driven, research initiatives that aim to achieve a visionary goal.

The scientific advance should provide a strong and broad basis for future technological innovation and economic exploitation in a variety of areas, as well as novel benefits for society.”

Scale: 10 year project period,
1 B€ project cost (500 M€ from EC)
Graphene (coordinated by Chalmers)
and the **Human Brain Project** (EPFL).
New flagships are in progress.



2013, October 1: Project start with a 30 month ramp-up phase.
2016, April 1: Enter Horizon 2020 phase.

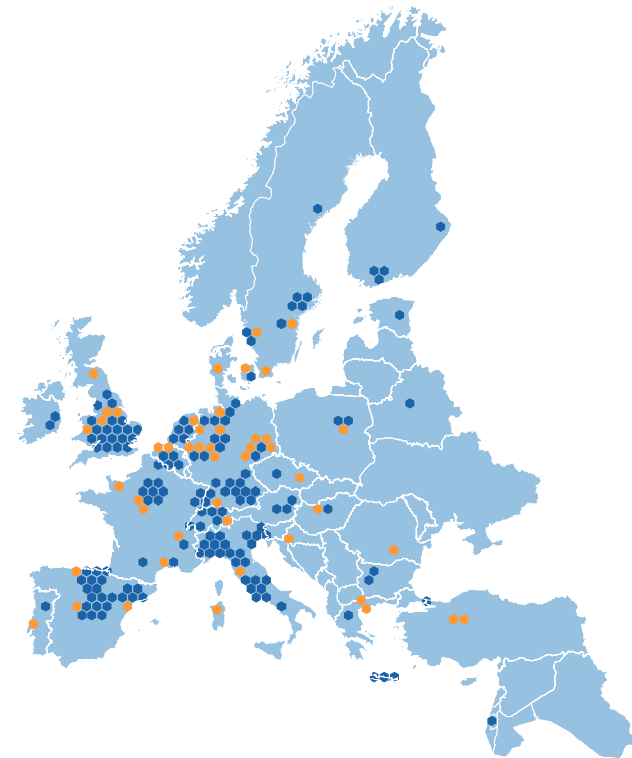
Core 1 today

Core 1 started on April 1, 2016:

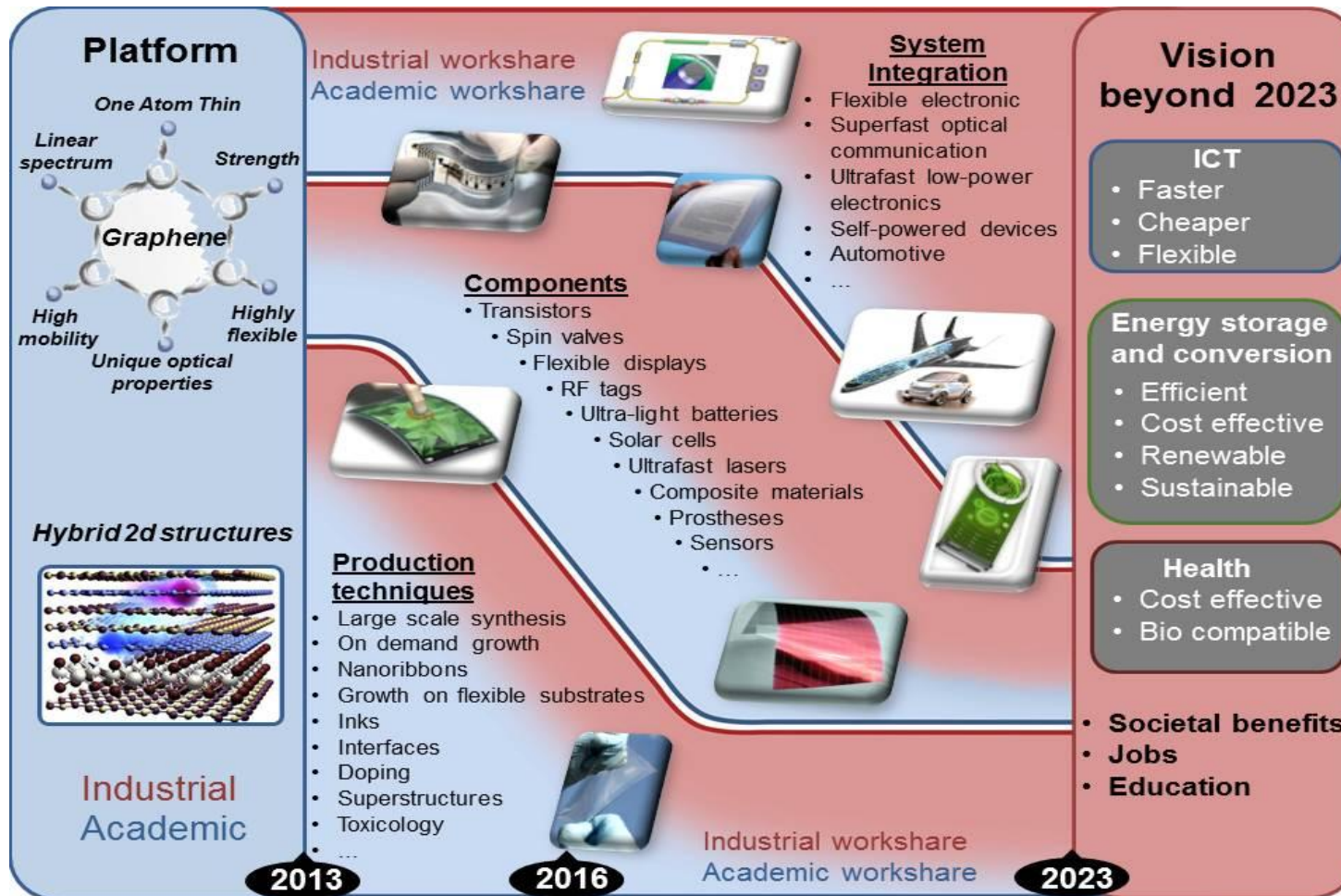
- 156 partners in 23 countries;
about 1/3 industry, 1/2 academia
and 1/6 other
- 15 S&T work packages,
5 supporting work packages
- 450 full-time equivalent persons,
over 1,300 individuals
- 80 Associated Members, many of whom
are involved in 19 Partnering Projects

Output includes thus far

- Nearly 1,500 publications with over 21,000 citations
- About 40 patents applied and 20 products launched
- Some 350 hired graduate students



Roadmap



Thank you for contributions to the presentation

- Helena Theander
- Jon Wingborg
- Johan Ek Weiss
- Sophie Charpentier
- Jari Kinaret
- Vincenzo Palermo



 SIO GRAFEN



GRAPHENE FLAGSHIP

ABB