William Blythe Graphene Oxide

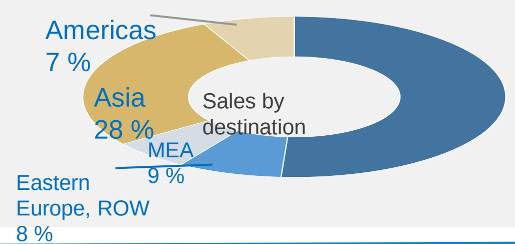
ANSI Standard Development Conference
March 2017

EMEA Division	ASIA Division	AMERICAS Division	SPECIALITY Division

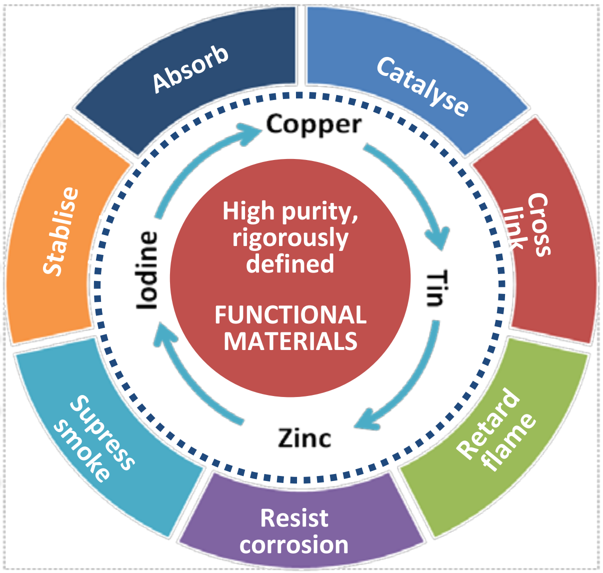
- Construction & Coatings
- Adhesives & Sealants
- Textile & Fibre Bonding
- Carpet & Foam
- Paper
- Health & Protection
- Monomers

SPECIALITY Division
- Perf Polymers
- Compounds
- William Blythe
- Powder Coatings

- £ 1.14 bn group revenue
- 2750 employees
- 100 countries
- 24 production sites



- Controlled bi / tri metallic precipitation
- Redox reactions
- Hydrothermal Synthesis
- Purification
- Product refinement
- Closed loop recycling
- Analytical Characterisation



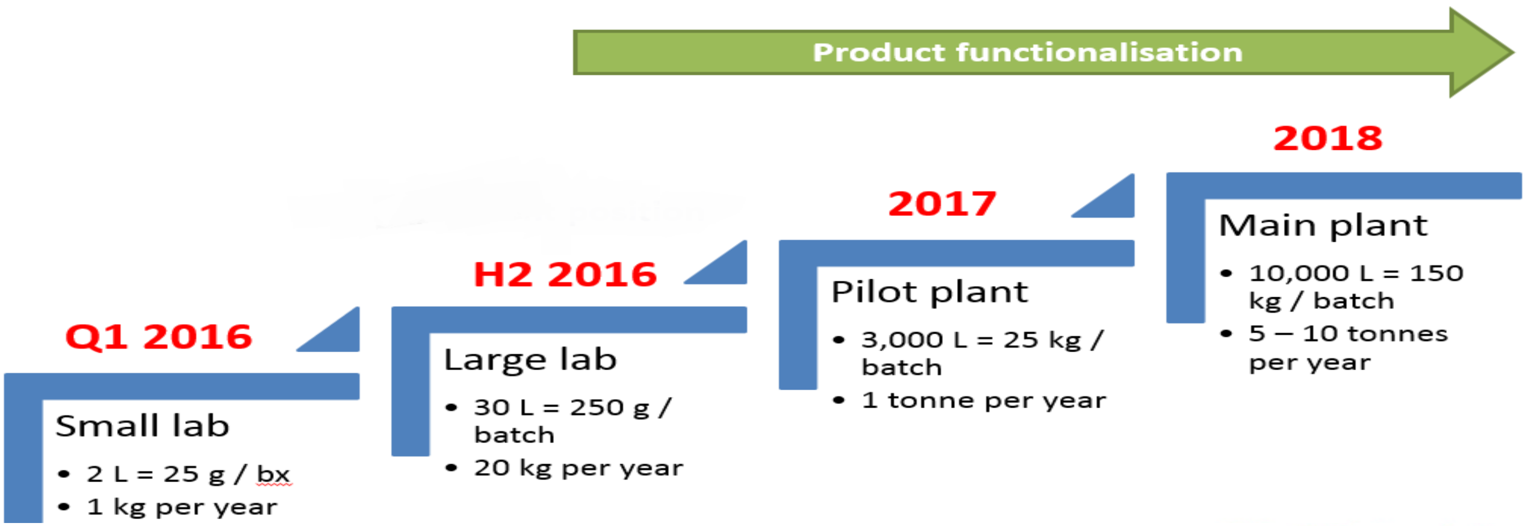
- A chemistry innovation business supplying differentiated technically advanced specialty products
- Current product portfolio functional derivatives of copper, tin, iodine
- Actively developing advanced materials such as graphene oxide, tungsten products, and perovskites

williamblythe Excellence in chemistry

Core Capabilities - Graphene Oxide

William Blythe has a wealth of experience and capabilities which have been applied to the development of GO

- Key raw materials (strong acids, oxidising agents) are within William Blythe core capabilities
- William Blythe are experts in redox chemistry
- William Blythe have expertise in controlling and measuring the physical properties of powders
- Well developed Process Safety Management System to allow the safe scale up of hazardous processes and a top tier COMAH site allows use of hazardous chemicals



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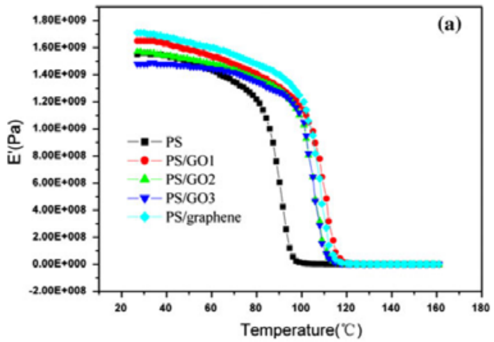
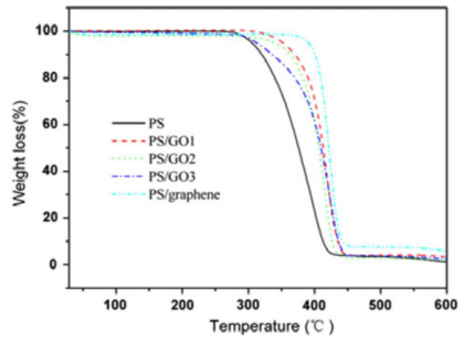
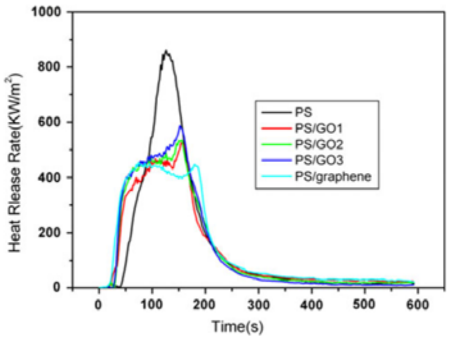
Excellence in chemistry

Improving Material Properties with Graphene Oxide

- Improved stiffness, increased mechanical-temperature resistance, improved thermal stability, decreased peak heat release in Polystyrene with blended GO







- Decreased electrical conductivity degradation with temperature in composites

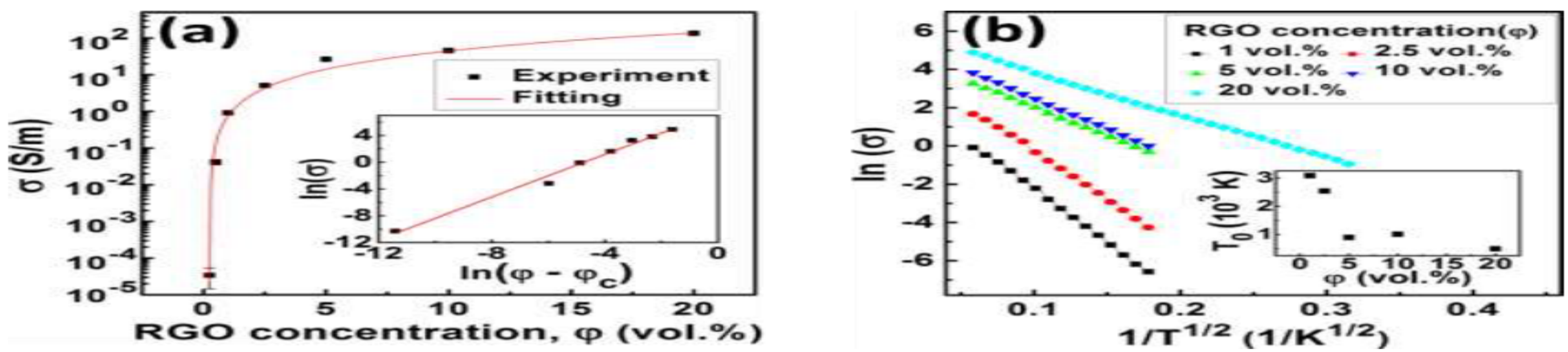
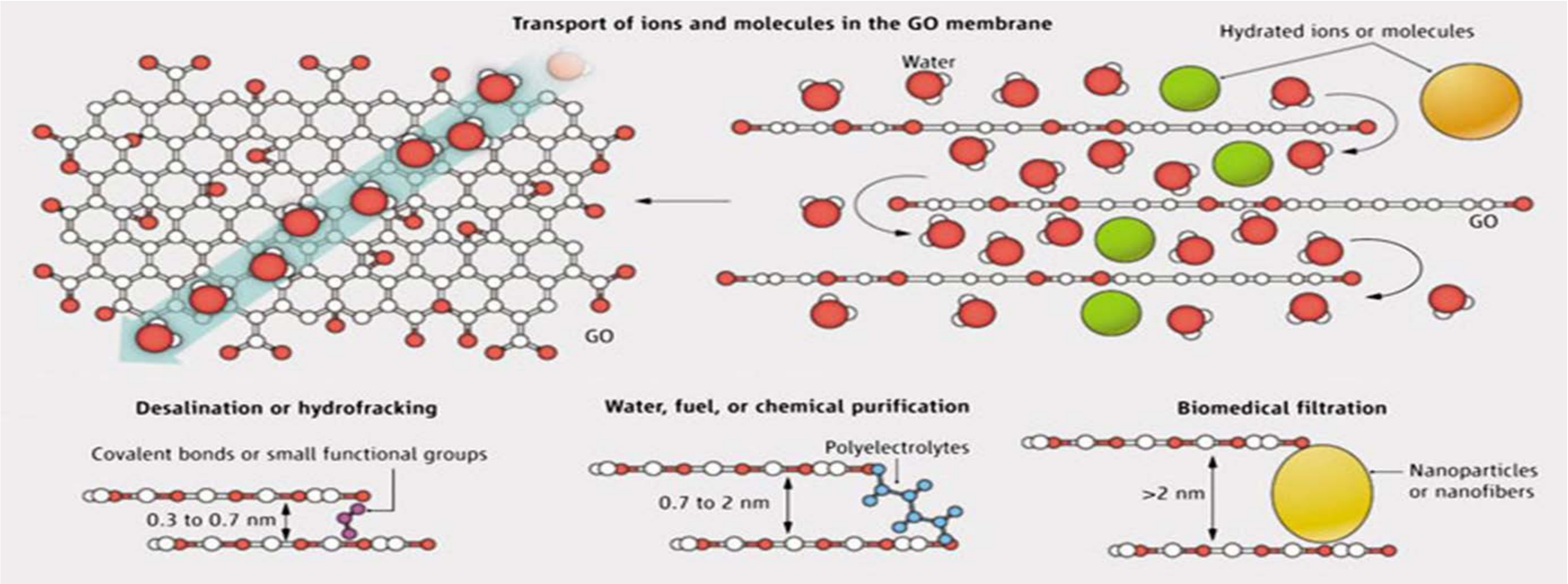


FIG. 2. (a) Electrical conductivity (σ) of RGO/PS composites with different RGO concentrations (φ) at 300 K (inset, $\ln(\sigma)$ vs. $\ln(\varphi - \varphi_c)$). (b) Temperature-dependent electrical conductivity ($\ln(\sigma)$ vs. $1/T^{1/2}$) at various RGO concentrations (inset, T_0 vs. φ).

[1] Han, Wu, J. Material Science, 22 February 2013

Improving Material Properties with Graphene Oxide

- Improved membrane performance



- Other applications including solar cells, graphene/polymer composite materials, batteries, supercapacitors, support for metallic catalysts, low permeability materials, biosensors, and multifunctional materials

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Challenges

- Variation in materials sold on the marketplace under the name "graphene oxide"
  - Leads to some instances of potential users claiming it doesn't work in their application when it may have benefits if a different grade was used
  - Difficult for users to compare prices between suppliers

- Concern over health effects
  - Some potential customers will not consider using nanomaterials in their research until there is conclusive data on the effects to human health
  - Cost of generating the required data is high, until graphene oxide is in high enough demand, difficult to justify costs

- Industry awareness of graphene oxide is a limiting factor
  - Range of applications GO can be used in is wide, without considering functionalised GO, but often not considered in R&D because its use is still academic
  - Cost in use can be an issue – potential users don't realise how low loading could be
  - Potential users might not have any interest yet because they aren't aware that GO is tuneable and available at commercially relevant quantities and prices