Founded in 1845, William Blythe manufactures inorganic speciality chemicals in the United Kingdom for a wide variety of applications.

We are a chemistry innovation business supplying differentiated, technically advanced specialty products.

Global Sales to more than 40 countries.

Team of highly skilled scientists, engineers and technicians.
Synthomer: Top 5 global supplier of emulsion and speciality polymers

- FTSE250 listed company
- Focus on organic growth and M&A
- £2.1 Bn Group revenue
- 4750 employees
- 24 Countries
- 38 production sites

Global Business

Three Global Business Units

- Functional Solutions - Adhesives, Coatings, Construction, Textile & Fibre Bonding
- Performance Elastomers – Health & Protection, Paper, Carpet & Compounds, Foam
- Industrial Specialities – Speciality Vinyl Polymers, Lithene, Powder Coatings, Monomers, Speciality Additives, William Blythe
Site Overview

- Effluent Plant
- Copper Plant
- Nitrates Plant
- Tin Plant + Hydrothermal Plant
- Iodine Plant
- Multi Purpose Plant
- QC/R&D
- Pilot Plant
- Warehouses
- Main Site Entrance
The manufacturing site is set over **approximately 26 hectares**

There are **five manufacturing plants** on site which cover our different chemistries and which are supported by our pilot plant.

The site has its **own wastewater treatment facility** where all the process effluent is treated before discharge to sewer.

The site is a **top tier COMAH site** and in combination with our IPPC permit this provides a **wide regulatory envelope** for the handling of very hazardous chemistries.

WB have experience of handling chrome VI, arsenic acid and chlorine.

WB can develop new products using hazardous chemistries and **scale to industrial volumes**.

The site is **accredited** to ISO, 9001:2015 (Quality), 14001:2015 (Environment) and 50001:2015 (Energy).

WB has been classified in the **top 25%** of companies for sustainability by Ecovadis with a silver rating.
<table>
<thead>
<tr>
<th>Chemical Catalysts</th>
<th>Coating Additives</th>
<th>Electronic Chemicals</th>
<th>Food &amp; Feed Additives</th>
<th>Life Science Reagents</th>
<th>Renewable Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Copper Carbonate</td>
<td>Flamtard™ H</td>
<td>Copper (I) Iodide</td>
<td>Basic Copper Carbonate</td>
<td>Copper (I) Iodide</td>
<td>Anode Materials</td>
</tr>
<tr>
<td>Copper (II) Nitrate (Solution)</td>
<td>Luxacal™</td>
<td>Copper (I) Iodide</td>
<td>Copper (I) Iodide</td>
<td>Graphene Oxide (dispersion)</td>
<td>Cathode Materials</td>
</tr>
<tr>
<td>Graphene Oxide (Dispersion)</td>
<td>Tin (II) Chloride (solution)</td>
<td>Graphene Oxide (dispersion)</td>
<td>Magnesium Nitrate (solution)</td>
<td>Periodic Acid (also available as solution)</td>
<td>Graphene Oxide (Dispersion)</td>
</tr>
<tr>
<td>Tin (II) Oxide</td>
<td>Periodic Acid (solution)</td>
<td>Potassium Iodate</td>
<td>Potassium Iodide</td>
<td>Sodium Metaperiodate</td>
<td>Luxacal™</td>
</tr>
<tr>
<td></td>
<td>Potassium Iodate</td>
<td>Potassium Iodide</td>
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<td></td>
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<tr>
<td>Pigment Precursors</td>
<td>Plating Materials</td>
<td>Polymer Additives</td>
<td>Process Chemicals</td>
<td>Print Chemicals</td>
<td>Purification Adsorbents</td>
</tr>
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</tr>
<tr>
<td>Copper Carbonate</td>
<td>Tin (II) Chloride (also available as solution)</td>
<td>Copper (I) Iodide</td>
<td>Basic Copper Carbonate</td>
<td>Periodic Acid (solution)</td>
<td>Duraguard™ S100</td>
</tr>
<tr>
<td>Potassium Iodide</td>
<td>Tin (II) Oxide</td>
<td>Potassium Iodide</td>
<td>Basic Copper Nitrate</td>
<td>Sodium Metaperiodate</td>
<td>Duraguard™ M100</td>
</tr>
<tr>
<td>Tin (II) chloride (solution)</td>
<td></td>
<td>Flamtard™ H</td>
<td>Magnesium Nitrate (solution)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin (II) oxide</td>
<td></td>
<td>Flamtard™ HF</td>
<td>Periodic Acid (solution)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flamtard™ S+</td>
<td>Potassium Iodate</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Flamtard™ V</td>
<td>Potassium Iodide</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Graphene Oxide (dispersion)</td>
<td>Tin (II) Chloride (also available as solution)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tin (II) Chloride</td>
<td>Tin (II) Oxide</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Specification/Typical Analysis

1% dispersion (10mg/ml)

<table>
<thead>
<tr>
<th>Analytical Parameter</th>
<th>Specification</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Brown/black</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>&gt;30%</td>
<td>XPS</td>
</tr>
<tr>
<td>Carbon</td>
<td>60-70%</td>
<td>XPS</td>
</tr>
<tr>
<td>Sulfur</td>
<td>&lt;2%</td>
<td>XPS</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>&lt;1%</td>
<td>XPS</td>
</tr>
<tr>
<td>Trace Metal Content</td>
<td>&lt;0.1%</td>
<td>ICP-OES</td>
</tr>
</tbody>
</table>

www.go-graphene.com
Functionality

Fourier Transform Infra-Red Spectroscopy

X-Ray Diffraction

X-Ray Photoelectron Spectroscopy

O-C=O
C=O
C-O
C-C sp2
O-H

www.go-graphene.com
Graphene Oxide from William Blythe Ltd

**Structure**

Predominantly monolayer and bilayer, lateral dimensions 2-5 microns

Atomic Force Microscopy

Scanning Electron Microscopy
Graphene Oxide from William Blythe Ltd: Specifications

Dispersibility

Fully dispersible in a range of polar solvents

5mg/ml

www.go-graphene.com
Application Areas

William Blythe is actively working with customers from a diverse range of market sectors and application areas.

The performance of graphene oxide can be impacted by both its physical and chemical properties.

Our team is working to develop the capabilities needed to tune the properties of graphene oxide for different applications.
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The performance of graphene oxide can be impacted by both its physical and chemical properties.

Our team is working to develop the capabilities needed to tune the properties of graphene oxide for different applications.
Graphene Oxide and Reduced Graphene Oxide in Battery Materials

Metal oxides have superior theoretical capacities to graphite, but suffer from high volume changes during charging and discharging.

The volume changes progressively reduce the battery capacity and lifetime.

<table>
<thead>
<tr>
<th>Anode material</th>
<th>Specific Capacity mAhg(^{-1})</th>
<th>Volume Expansion %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphite</td>
<td>372</td>
<td>12</td>
</tr>
<tr>
<td>Silicon</td>
<td>4200</td>
<td>320</td>
</tr>
<tr>
<td>CuO</td>
<td>674</td>
<td>220</td>
</tr>
<tr>
<td>NiO</td>
<td>718</td>
<td></td>
</tr>
<tr>
<td>SnO</td>
<td>875</td>
<td>360</td>
</tr>
</tbody>
</table>
Wrapping active particles with rGO should improve battery performance by reducing particle volume changes and improving conductivity in the electrode by preventing particle aggregation.
Graphene Oxide and Reduced Graphene Oxide Functional Materials

Graphene oxide

Metal oxide precursors

Chemical reducing agent

or

Post reaction thermal reduction

I. Mixing

II. Wrapping

III. Templating

Metal oxide particle

rGO

Schematic, for illustrative purposes only

Process-dependent morphology
Utilizing Cyclic Voltammetry to Understand the Energy Storage Mechanisms for Copper Oxide and its Graphene Oxide Hybrids as Lithium-Ion Battery Anodes

Cameron Day, Katie Greig, Alexander Massey, Jennifer Peake, David Crossley, Prof. Robert A. W. Dryfe

First published: 09 December 2019 | https://doi.org/10.1002/cssc.201902784
Copper Oxide-Reduced Copper Oxide Anode Materials Example

1. Reactants $\rightarrow$ CuCO$_3$ $\rightarrow$ CuO

2. Reactants $\rightarrow$ CuCO$_3$ $\rightarrow$ CuO $\rightarrow$ glucose $\rightarrow$ carbon coated CuO

3. Reactants $\rightarrow$ CuCO$_3$ $\rightarrow$ CuO $\rightarrow$ rGO/CuO (1)

4. Reactants + GO $\rightarrow$ CuCO$_3$/GO $\rightarrow$ rGO/CuO (2)

5. Reactants + GO $\rightarrow$ CuCO$_3$/GO $\rightarrow$ rGO/CuO (3)
Copper Oxide-Reduced Copper Oxide Anode Materials Example

1. Reactants → CuCO$_3$ → CuO

2. Reactants → CuCO$_3$ → CuO + glucose → carbon coated CuO

3. Reactants → CuCO$_3$ + GO → rGO/CuO (1)

4. Reactants + GO → CuCO$_3$/GO → rGO/CuO (2)

5. Reactants + GO → CuCO$_3$/GO → rGO/CuO (3)
Pure Copper Oxide
Pure Copper Oxide
CuO/rGO (2) 2% GO

rGO wrapped particles
rGO increases stability compared to pure inorganic
CuO/rGO (2) 5% GO

rGO wrapped particles
CuO/rGO (2) 5% GO nanoparticle templating
CuO/rGO (2) 5% GO

Increasing rGO concentration further increases stability and also initial capacity.
Sn$_2$P$_2$O$_7$/rGO

Sn$_2$P$_2$O$_7$ wrapped particles

Greater stability with rGO
SnO/rGO

Greater stability with rGO

rGO wrapped particles

SnO

10 µm

SnO/rGO

Graph showing specific capacity and coulombic efficiency over cycle number for SnO/rGO and comparison with rGO wrapped particles.
William Blythe Ltd Graphene Oxide

- MECHANICAL STRENGTH
- BARRIER PROPERTIES
- DRUG DELIVERY
- CATALYST SUPPORT
- ENERGY STORAGE
- WATER FILTRATION
- CONDUCTIVE INKS

- Demonstrated application benefits
- High quality, consistent material
- Ready for your challenge
For more information on William Blythe graphene oxide, and web-sales, please visit www.GO-graphene.com

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