haydale

"enabling technology for the commercialisation of graphene"

Presentation
17th June 2014

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The graphene opportunity

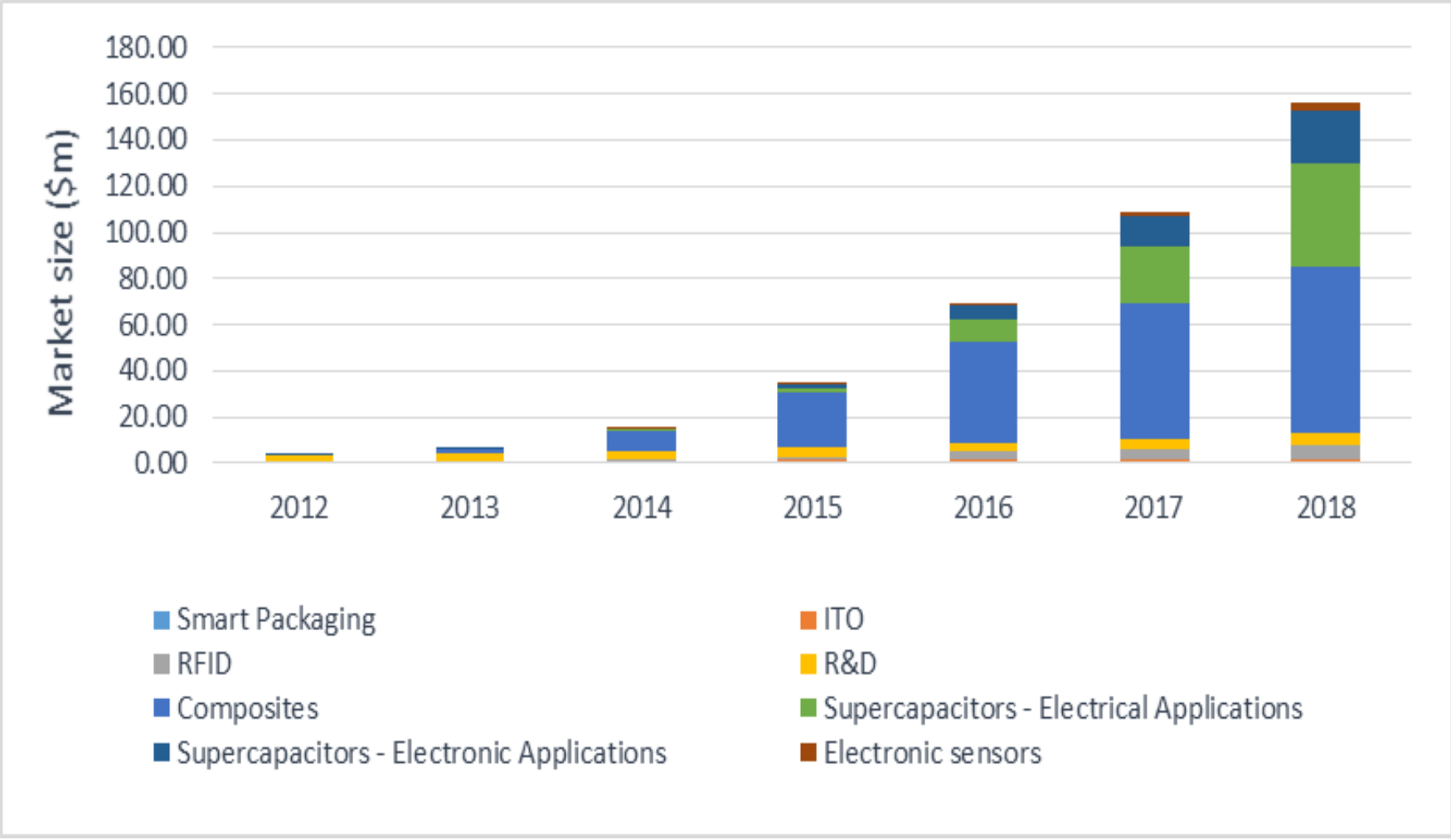
- Claimed to be the disruptive technology for the 21st Century
  - Potential to revolutionise materials technology and electronics
- Graphene - exceptional electrical, mechanical and thermal properties
  - Markets such as batteries/energy, composites, conductive inks and films
- Industry challenge - to mix and bond Graphene - a carbon which is inherently inert
- Solution – Surface **functionalisation**[1]
  - Haydale has a proprietary scalable plasma process to functionalise graphene
- Multiple routes to market
- IPO on 14th April raised £6.6m to accelerate business development

[1] functionalisation of nanomaterials provides a means by which the surface chemistry of the materials may be modified

What is graphene?

- Pencil lead made from millions of graphene layers
- 3 million sheets are 1mm thick
- More conductive than copper
- 200 times stronger than steel
- Thinnest imaginable material
- Largest surface area (c.2,630 m^2 per gram)
- Stiffest known material (stiffer than diamond)
- Most stretchable crystal (up to 20% elasticity)
- Completely impermeable to gases

Forecast growth of graphene markets



Source: IDTechEx, Graphene Analysis of Technology Markets and Players 2012-2018

Potential end applications

Batteries and energy devices

Energy – super capacitors

Electronic sensors

Composites

3D Printing

Potential end applications

Composites & EMS

Flexible printed electronics

Barrier Films

Composites

Bio medical sensors

The Graphene challenge

Challenges include:

- Graphene as a Carbon is inherently inert
- Properties not realised unless dispersed and bonded
- Tailored **Functionalisation** is crucial for dispersion
- Maintaining structural integrity
- Cost reduction
- Limited production scalability
- Environmental impact

The Haydale solution

Haydale's solution: Plasma

- Tailored and controllable **functionalisation**[2]
- No impurities added by the process
- Maintains structural integrity
- Match functionalised material to application
- Cost effective when scaled up
- Environmentally friendly

Epoxy (no filler)

0.5 wt% Non Functionalised CNT in epoxy resin

0.5 wt% Functionalised HDPlas CNTs in epoxy resin

[2]Functionalisation verified by National Physical Laboratory. Patent pending.

Haydale's key milestones

2003-2010
Haydale acquired 2010
Investment £500,000

2010-2011: Research

- Process developed and patent portfolio created
- Process proved and scale up started
- Reactor commissioned
- Initial research sales

2012-2013: Facility

- Group's strategic direction set
- Haydale profile created
- Nanomaterials handling facility established
- First collaboration and distribution agreements signed

2014 –>: Sales and marketing

- Sales and marketing growth
- Promotion of technology
- Scale up of manufacturing capacity
- Further collaboration and distribution agreements
- Verification of process

Aerospace Corp Research

Third party independent verification on use of Haydale O2 fn GNPs:

- Significant strength improvements in toughened epoxy composites.
- The reported increases are >2x in tensile strength and modulus of an epoxy composite.
- The addition of increasing amounts of GNP resulted in strength increases of over 125% and toughness improvements of 100% over that of similarly cured, unreinforced material.

Reported in the Journal of Applied Polymer Science 10.1002/APP.40802

Multiple routes to market

Working in partnership with raw material producers and applications companies

- Revenue streams – cascade effect:
  - Online sales of product through www.haydale.com and Graphene Supermarket
  - Third party distributors – AMG Mining AG / INSCX exchange
  - Grant funded projects – TSB / Horizon 20:20 – e.g. sensors
  - Individually based research and development projects – e.g. supercapacitors
  - Commercial projects and strategic collaborations – e.g. conductive inks
  - In-house manufacturing
  - Licensing
- Haydale strategic position: preferred solutions provider through enabling technology
- Create demand pull: *designed in* to the next generation of developed applications

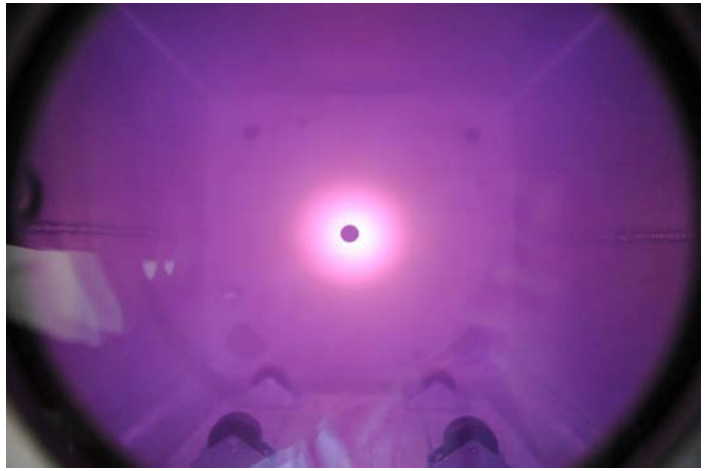
Board and key management

Executive Directors

- Ray Gibbs (Chief Executive Officer)
- Matt Wood (Finance Director)
- Dr. Chris Spacie (Technical Director)

Non-executive Directors

- John Knowles (Chairman)
- Tony Belisario (Deputy Chairman)
- Graham Eves (Independent Director)
- Roger Humm (Independent Director)
- Roger Smith (Independent Director)



Key management

- Dr. Martin Kemp (Business Development Director)
- Dr. Chris Stirling (Development Manager)
- Martin Williams (Technical Manager)
- Marie Davies (Project and Supply Chain Manager)

Use of proceeds

Raised £6.6m (£1m of which is VCT/EIS qualifying) to fund:

- Headcount and infrastructure
- Capital expenditure
- Sales and marketing
- Collaboration projects
- Working capital and
- Joint ventures and acquisitions

Listing and post float key statistics

- Placing size £6.6m at £2.10- Pre money value at £17m
- Lock-up and orderly market for 24 months over 22% of existing shares, including management
- 55% of existing investors under EIS
- Former founder- 7.42% taken up on 1st May
- On Listing shares in issue 11,247,823 held by 193 shareholders
- 7 market makers
- AIM Ticker: HAYD.L

The Haydale opportunity

- Graphene has potential to revolutionise materials technology
- Commercial opportunities for graphene are vast - but
    - GRAPHENE NEEDS SPECIFIC FUNCTIONALISATION
- Haydale's proven, enabling technology could make this a reality
- First mover advantage: create demand pull.Designed in to new applications
- Team has extensive nanomaterials and technology commercialisation expertise; and
- Licensing model should deliver high returns from low investment

Appendices

1. Board & Key Management
2. Shareholders and financial data
3. Graphene
4. Technology
3. Haydale product portfolio

Board

- **John Knowles, BSc Eng (Hons) (Chairman)**

John has significant nanotechnology experience. He was until recently chairman of NanoSight Limited (sold to Spectris plc) and currently is the Chairman of the Nanotechnology KTN Advisory Board. He is a member of UK Government's Nanotechnology Strategy Forum. His 30 years' experience includes 2 years as MD of a Morgan Crucible subsidiary and Chairman/director of several successful technology companies - including Davin Group Ltd, Stratophase Ltd and Michelson Diagnostics Ltd.

- **Ray Gibbs, BA (Hons), FCA (Chief Executive Officer)**

Ray is a Chartered Accountant, and former Deloitte audit and corporate finance partner for 9 years. He has spent the last 18 years in industry as CFO or commercial director of high technology, manufacturing and fast moving consumer goods businesses both in the quoted and private arenas with sales ranging from £500,000 to £500 million. Ray was a former CFO of Chemring Group Plc.

- **Dr. Chris Spacie, C. Eng, MIMMM (Technical Director)**

Chris is a materials scientist and Chartered Engineer with over 30 years of experience in commercial R&D, process innovation, plant design and manufacturing. He was formerly technical director of Morganite Electrical Carbon Ltd. a division of Morgan Crucible Plc and is a primary inventor in fields such as fuel cell materials, composites and ballistics.

- **Matt Wood, BA (Hons), ACA (Finance Director)**

Matt is an experienced professional having worked as a financial and non-executive director with a variety of companies with a background in AIM listed small-cap corporate finance. Matt will work part time until the business needs a full time finance director. He is currently part time finance director for Sula Iron and Gold plc and is a non-executive director of Avarae Global Coins plc and Westminster Group Plc.

Board (cont.)

- **Tony Belisario, B Tech (Hons) (Vice Chairman)**

Tony is a chartered engineer who has spent most of his working life in management in manufacturing businesses using diverse technologies operating in global markets. In addition, Tony has also managed businesses backed by private equity and has led an MBO. Currently, in addition to being part time deputy chairman of HGI, he serves on the Council of Brunel University.

- **Graham Eves, MA (NED)**

Graham joined GKN plc in 1967 where he spent 13 years operating across multiple overseas jurisdictions including, for the last 5 years, setting up and running a special operation for GKN plc's head office in Switzerland. He returned to the UK in 1980 to work in venture capital and establish his own international business consultancy. He co-founded and was chairman of an automotive technology company, Mechadyne (now part of KolbenschmidtPierburg AG). He was also chairman of PCB manufacturer, Lyncolec Limited, chairman of a special security company and a director of 3PC Investment Trust. Graham is a Non-Executive Director of AB Dynamics and was directly involved in the AIM flotations of AB Dynamics plc, Antonov plc and Transense Technologies plc. He was on the AIM advisory committee of the London Stock Exchange for 6 years and has a Master of Arts degree in Modern and Medieval Languages from the University of Cambridge.

- **Roger Humm, MBA, BSc (Hons), FCA (NED)**

Roger is a commercial and financial director with over 20 years in industry with extensive understanding of technology businesses. Having held positions as a finance director and company secretary in public & private settings, Roger has accumulated knowledge of capital transactions covering funding, acquisitions, divestments, in- and out-licensing and spin outs. He is currently part time vice president of finance of AIM quoted Ixico plc.

- **Roger Smith, BSc Physics (NED)**

Roger is a senior vice president and responsible for a $50 million turnover division of Petrofac Plc. He has spent 35 years in the oil and gas industry and has set up and sold 2 successful engineering consulting companies.

Senior Management

- **Dr Martin Kemp (Business Development Director) FIMMM, MCIM, DipM, C.Eng**

Martin is a chartered marketer with 20 years' experience in nanotechnology products and high technology markets. Formerly with QinetiQ, DTI GlobalWatch Service and the TSB Nanotechnology Knowledge Transfer Network managed by the Centre for Process Innovation, Martin joined on 1 April 2014.

- **Dr. Chris Stirling (Development Manager - Energy) Ph.D BSc**

Chris was formerly at Morgan Crucible and Morgan Advance Materials, and joined in January 2014 to focus on the energy sector. Chris' recent projects include thermal transfer, energy storage and the electrochemical production of low cost carbon nano tubes.

- **Martin Williams (Technical Manager) BEng, MRes, MPhil**

Martin is the joint inventor of Haydale's proprietary plasma process, having joined Haydale in 2006. He is responsible for the QA and QC in Haydale. Martin holds degrees in Mechanical Engineering, Recycling Technology and Materials Science.

- **Marie Davies (Project and Supply Chain Manager) BA**

Marie has 20 years experience in project management and supply chain gained at Morgan Crucible, GSK and Thales. Marie has been a consultant with Haydale for 6 months and subscribed for shares in December 2013. She joined Haydale on 1 April.

At Admission, the Group had 11 employees, excluding the non executive Directors.

Shareholders pre IPO

Shareholder	%
Ray Gibbs (CEO)	5.39%
Anthony Belisario (NED)	4.36%
Roger Smith (NED)	3.30%
Others	1.15%
Directors and staff (Total)	14.20%
Former directors and staff	19.35%
Other EIS investors	55.00%
Others	11.45%
TOTAL	100%

Historic financial summary

	6 months ended 31 December 2013	Year ended 30 June 2013	Year ended 30 June 2012	Year ended 30 June 2011
	£	£	£	£
Revenue and Other Income	58,104	145,742	133,171	18,438
Operating Loss	(580,116)	(1,056,337)	(642,029)	(656,797)
Loss for the year / period	(568,239)	(992,380)	(608,532)	(582,380)
Cash and Bank	758,322	54,464	149,313	16,828
Net Assets	1,588,241	992,125	1,185,903	627,644

- Revenues include web based sales, research projects and research development grants
- Taken advantage of commercial revenue opportunities as they have arisen
- Raised equity financing of £4.5 million (July 2010 to January 2014)

The Haydale technology

The key features of Haydale's technology are:

- Low pressure and low energy, cold plasma technology
- Simple one stage production process; and
- Removes impurities with little damage to the base materials

The benefits of Haydale's technology are:

- Achieves optimum dispersion into a host material to improve performance;
- Controllable functionalisation
- Environmentally friendly; and
- Not tied into a single supply of raw materials.

Graphene – Functionalisation

- Functionalisation of nanomaterials provides a means by which the surface chemistry of the materials may be modified
- Carbon is an inert material that is difficult to react with other elements and compounds and to disperse in liquids
- The reason for this is the closed internal bonding structure that provides few sites on which other chemicals can bond
- Surface modification changes the physical, chemical or biological characteristics of the surface in order to make the carbon material more suitable for the intended application
- The modification can be done by different methods with a view to altering a wide range of characteristics of the surface, such as: roughness, hydrophilicity, surface charge, surface energy, biocompatibility and reactivity.

Haydale's production facility

- Purpose built production facility of 5,000 sq. ft. at Ammanford, near Swansea, South Wales, completed at a capital cost of £0.5m in May 2013
- ISO9001 accredited

- Capacity to house a number of plasma reactors and can accommodate significant expansion. There are currently two in operation with a further machine on order for delivery expected to be in early June 2014.

Graphene

- Thinnest imaginable material
- Largest surface area (c.2,630 m^2 per gram)
- Strongest material ever measured (theoretical limit)
- Stiffest known material (stiffer than diamond)
- Most stretchable crystal (up to 20% elasticity)
- Record thermal conductivity (outperforming diamond)
- Completely impermeable to gases
- Conducts electricity in the limit of no electrons

Graphene – the graphene market

The distinctive electronic, thermal and mechanical properties of graphene make it a potentially disruptive technology across a raft of industries where commercial opportunities are vast.

These industries include high speed consumer electronics, information processing solutions, biosensors, super-capacitors that could be used in place of batteries, mechanical parts and composites for cars and aircraft. Dispersed into yarns and fibres it becomes an anti-static, fire retardant, fully recyclable carpet, or a Kevlar replacement.

Opportunities are anywhere that advanced materials are required:

- Conductive Inks-Flexible electronics
- Super thin, flexible touch screens
- Sensors – gas and bio medical
- Photovoltaics
- Platinum catalyst replacement – hydrogen fuel cells
- Lithium-Ion batteries – faster charging and better storage
- Water filtration and thin film barriers for food hygiene
- Graphene infused yarns and fibres for anti-static, fire retardant, recyclable carpets – Kevlar!
- Numerous military and commercial applications

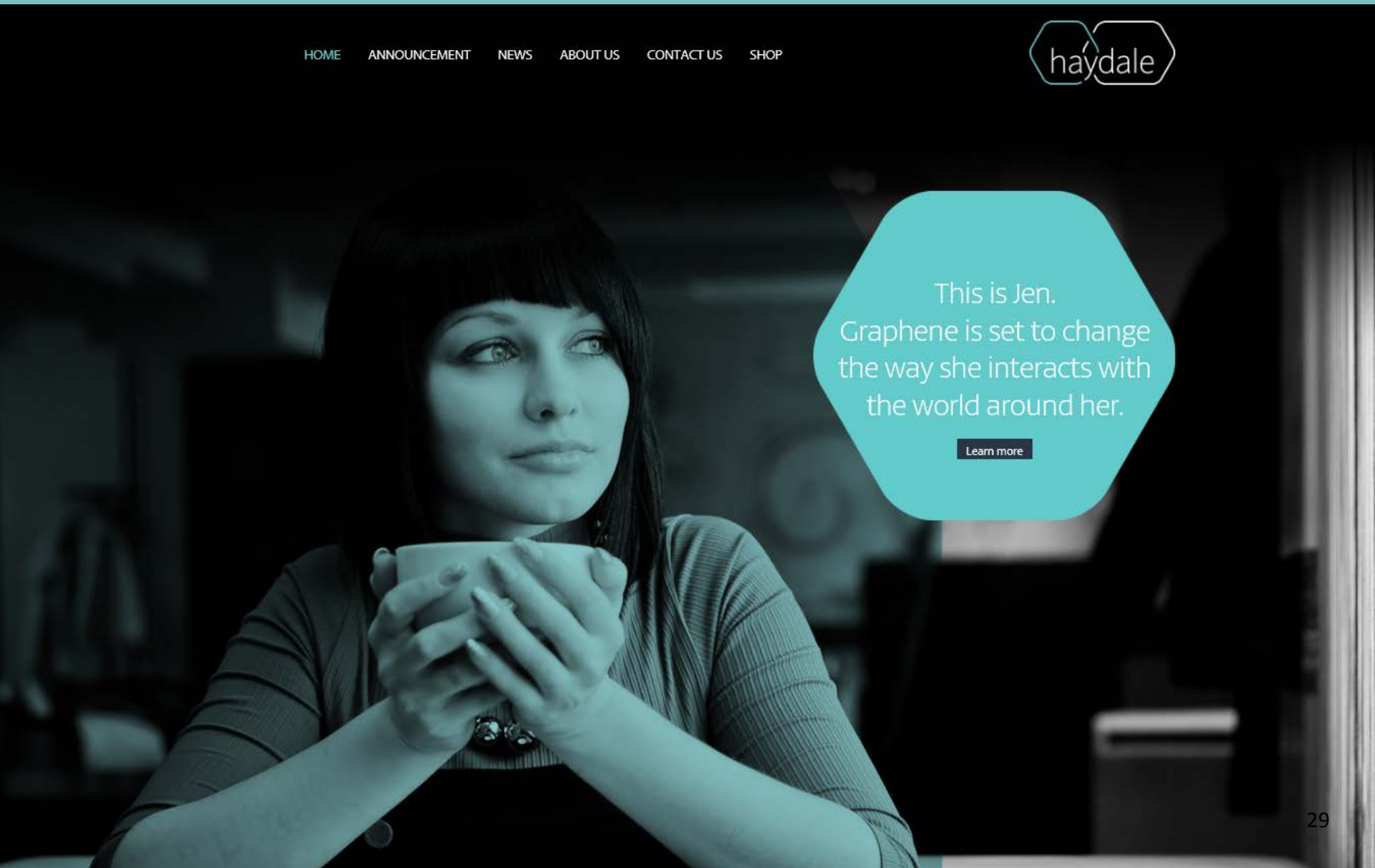
Graphene – the market opportunity

- Graphene's properties mean that it has the potential to be used in a wide range of applications across a host of market sectors.

- A recent report from leading research institution IDTechEX (12th September 2012) indicates that the market for graphene based products, as part of the nanomaterials market will reach $100m by 2018 growing to $575m by 2022.

- the main go-to-market strategy for graphene would be replacing an existing component in an existing product. Depending on the target market, the incumbent or rival materials could be carbon black, carbon fibre, graphite, carbon nanotubes, silver nanowires, Indium Tin Oxide (ITO), silver flakes, copper nanoparticles, aluminium, silicon, and Zinc Oxide (ZnO).

Haydale- Making the difference



haydale

Info@Haydale.com

Website: www.haydale.com

Tel: +44(0)1269 842946