Graphene Technologies in Advanced Manufacturing

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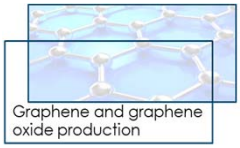
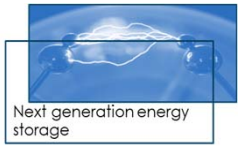
Introduction

Simon Savage, Managing Director, Ionic Industries and Founding Director of the Australian Graphene Industry Association

Ionic Industries is a technology platform based on our unparalleled knowledge and research capabilities in the field of graphene materials. Leveraging the depth of talent in Australian universities, Ionic aims to commercialise university-born technologies in water treatment and energy storage applications.





The Australia Graphene Industry Association (AGIA) is a Peak Industry Body, established at the end of 2017, to represent Australian companies, researchers and community voices interested in the economic value that will be driven by graphene.

Advocacy, representation to government, standardisation, content and facilitation.

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What is graphene?

The strongest and hardest material in the world. Harder than diamonds and 200 times stronger than steel.

Amazing optical properties. A one atom thick sheet will absorb only 2.3% of visible light, making it transparent.

Graphene is exceptionally light and stretchable. Graphene weighs only 0.77 milligrams per square metre and is stretchable up to 20% of its initial length.

Completely impermeable. Even helium atoms cannot pass through it.

Very high thermal conductivity. 5 times the conductivity of graphite.

1,000,000 better electrical density than copper and conducts electricity close to the speed of light with virtually no resistance.

Chemically inert however it can "absorb" different atoms and molecules, leading to changes in its properties. Can be functionalised to create materials such as GO and fluorinated graphene.

Graphene is also capable of self-healing.

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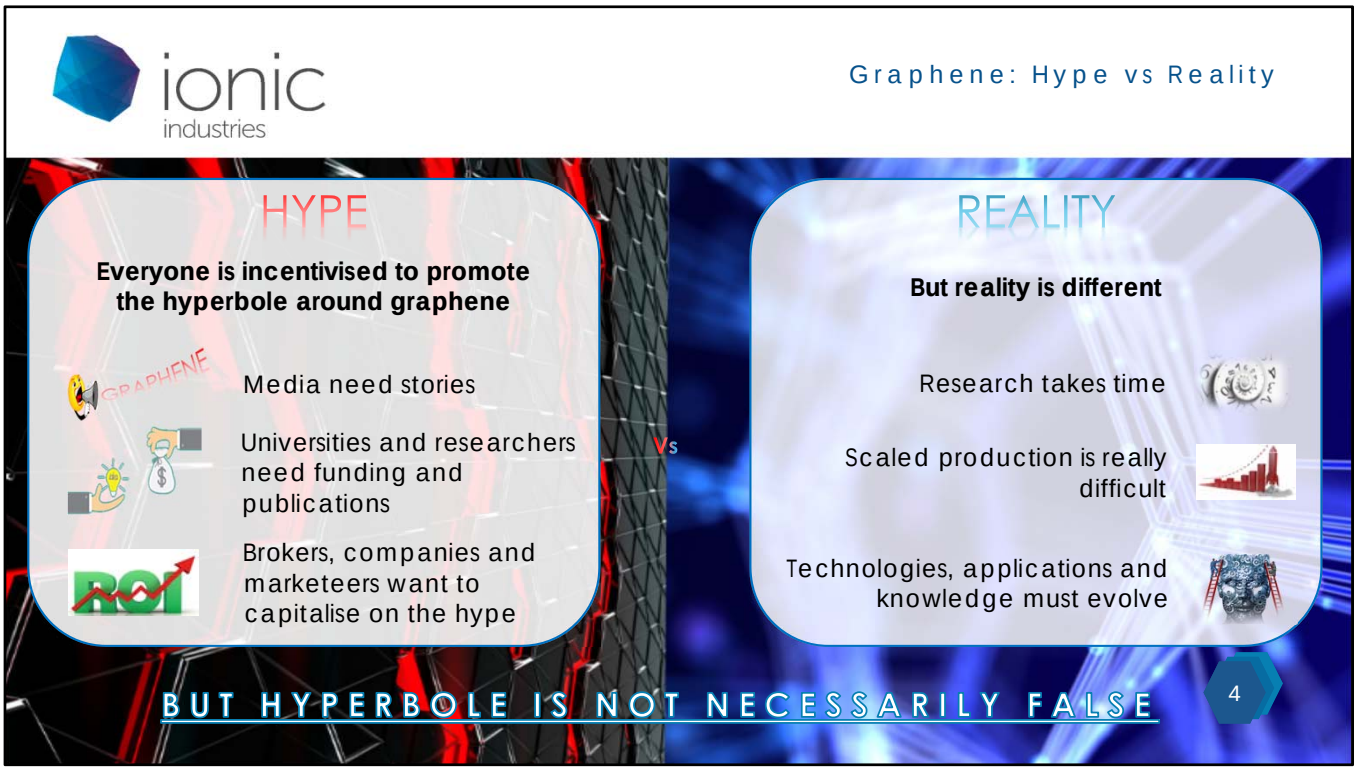
Graphene has a diverse range of extraordinary properties



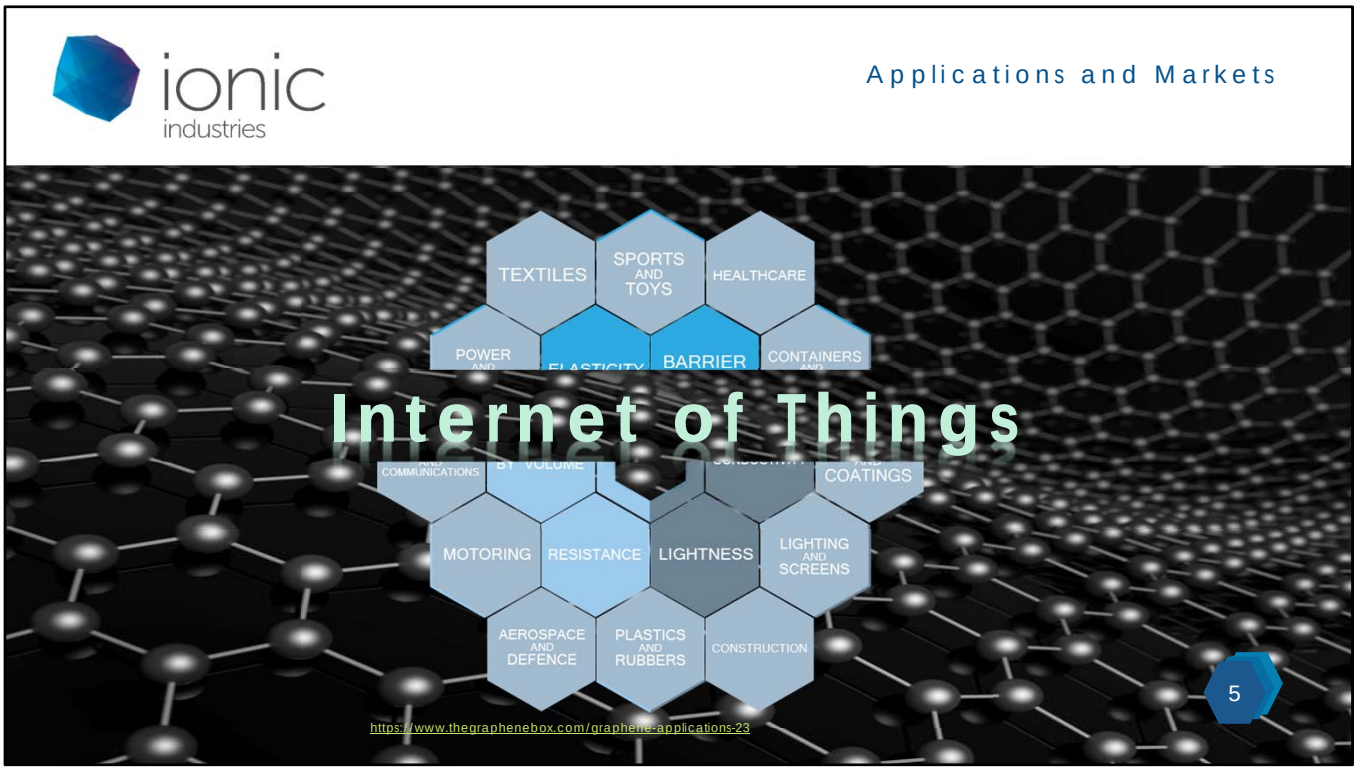
Hype around the potential for graphene has developed over the past few years and relatively limited commercial applications has left many commentators disappointed, claiming that the material has been over-hyped and that maybe it will never be commercialised.

This has been driven partly by the fact that most people involved in graphene are incentivised to support the hype. The realities of R&D have meant that few commercial applications of graphene have emerged.

- The realities are that R&D takes a long time – longer than the people promoting the hype would like, and unfortunately longer than most people's attention span.
- Commercial upscaling of technologies is really hard – even when a commercial application is identified, making the products in large scale using graphene poses a diverse range of challenges.
- Lastly and most importantly, it takes a long time for the body of knowledge surrounding graphene technologies to develop. It will never be the case that all of the potential applications for a new technology will be delivered together. One applications will come first, people will learn, new partnerships will form, and eventually that foundation will be expanded into other applications. E.g. the Li-ion battery took 25 years to bring from the Sony Discman to widespread application.

Despite all this, and while the hype may be exaggerated, that does not mean its untrue. All of the properties of graphene mean that there will be extraordinary opportunities

and advances across almost every industry on earth, it just hasn't happened yet.



While there are many applications where graphene will be critical, the IoT stands out as one of the most significant. The properties of graphene (conductive and structurally strong, very light, high surface area) will enable the development of “smart” things, things that will be connected to the internet to create the IoT. So graphene may well be one of the most important factors in evolution of the IoT.

E.G. smart concrete, roads, structural systems, smart composite materials, sensor platforms, medical devices, wearable technologies etc.

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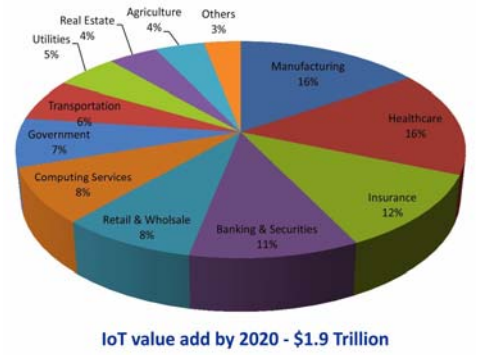
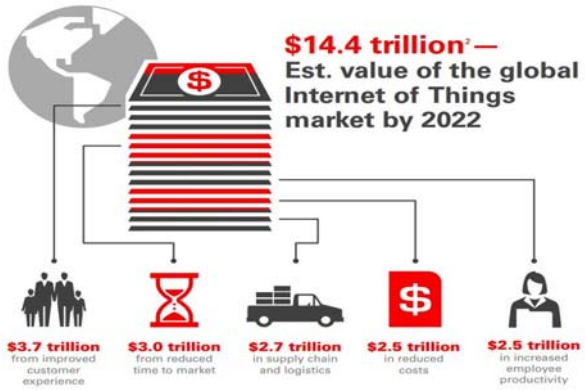
The "Internet of Things"



Gartner



Forbes

Cisco believes the market size will be $19 trillion by 2025. By comparison, world military expenditure is about $1.8 trillion.

Because graphene can be used to create "smart" objects, it will central to building out the technologies upon which the IoT is built.

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And if the IoT will be built on the strengths of graphene, that will give rise to extraordinary opportunity in the graphene industry, a good chunk of the estimated USD 19 trillion in value that the IoT will deliver.

https://www.forbes.com/sites/louiscolumbus/2015/12/27/roundup-of-internet-of-things-forecasts-and-market-estimates-2015/#4e4e5b084b93

http://iotworm.com/global-internet-of-things-market-analysis/

https://www.cnbc.com/2016/06/30/a-19-trillion-digital-revolution-is-coming-and-the-us-is-lagging-cisco-john-chambers-viva-tech.html

https://www.sipri.org/sites/default/files/YB16-Summary-ENG.pdf

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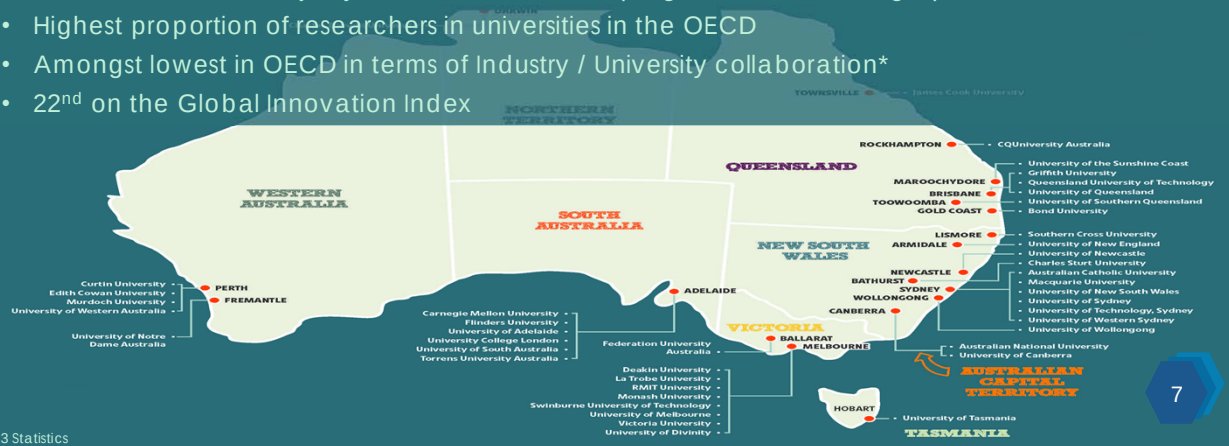
The Opportunity: Australia's R&D Resources

While Australian Manufacturing evolves to leverage advances in additive manufacturing, digital manufacturing and robotics, there is an extraordinary wealth of graphene knowledge that can facilitate and strengthen of offering of Australian manufacturers.

- 44 Universities, the majority of which have some programs focused on graphene
- Highest proportion of researchers in universities in the OECD
- Amongst lowest in OECD in terms of Industry / University collaboration*
- 22nd on the Global Innovation Index



*2013 Statistics

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Most of Australia's 44 universities have some work going in relating to graphene, and many of those are at the very cutting edge of their fields. The opportunity is here for Australian companies to leverage this wealth of expertise – but we have some challenges to overcome in developing relationships between universities and industry.

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Risks in Graphene and Industry 4.0 – the Global Race

There is much opportunity, but with opportunity comes risk

Extraordinary amount of work being done globally on graphene technologies – Manchester, EU Graphene Flagship, Samsung in Korea, Chinese companies for graphene production etc…

The challenge will be to leapfrog existing technology, not incrementally improve on it

Potential for catastrophic disruption if these opportunities are not pursued

IP protection and strategy will be critical to avoid conflict and mitigate risk of IP theft

"The 4th Industrial revolution is set to swiftly alter the competitiveness of nearly all industrial sectors across the world, as well as change long-held dynamics in commerce and global economic balance of power"

www.prnewswire.com/news-releases/industry-40-market-will-reach-214b-by-2023-300583073.html.

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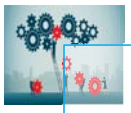
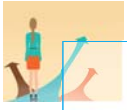
What can we do to realise this opportunity?



Collaborative consortia for R&D



Refocus and realign existing resources

Target global markets with high value manufacturing utilising graphene technology, particularly those technologies around IoT applications

Beat the brain drain by working to identify talent and incentivise them to stay in Australia

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- With so much work being done globally, Australian universities and companies will need to work together to effectively leverage these opportunities. Cooperation and co-opetition will win the day, not antagonistic and destructive competition.
- It will not be enough to simply support graphene research in the margins or as side projects. Companies need to divert significant resources from current work into graphene R&D and commercialisation activities.
- High value manufacturing will suit Australian strengths better than lower value applications.
- If our greatest strength is in our researchers in universities, we need to do everything we can to keep them in the country. This will require sustained and long-term effort amongst everyone in the graphene ecosystem to realise – to develop career paths, and collaborations that will see easy transfer of knowledge and look after those people who underpin the opportunity.

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Thank You

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