



***“Expanding the frontier of materials application
through the use of Graphene”***

About 2DM: High Quality Graphene



Management



Dr. Ricardo Oliveira
Co-founder and CTO

+15 years experience in
Mat. Science and Eng.
Led the development of
2DM's technology



Chen Chon Fook
VP of Manufacturing

+20 years management
experience in high
volume Manufacturing at
Motorola, HP and GE



Prof. Antonio Castro Neto
Co-founder and Advisor

Director, CA2DM – NUS
"The godfather of graphene"

Advisors



Prof. Kostya Novoselov
Advisor

Winner of the 2010
Nobel Prize in Physics
Professor at NUS – CA2DM



Patrick Teyssonneyre
Advisor

+19 years of experience
turning technologies into
businesses. MBA at MIT Sloan

Supported by:



Investors:

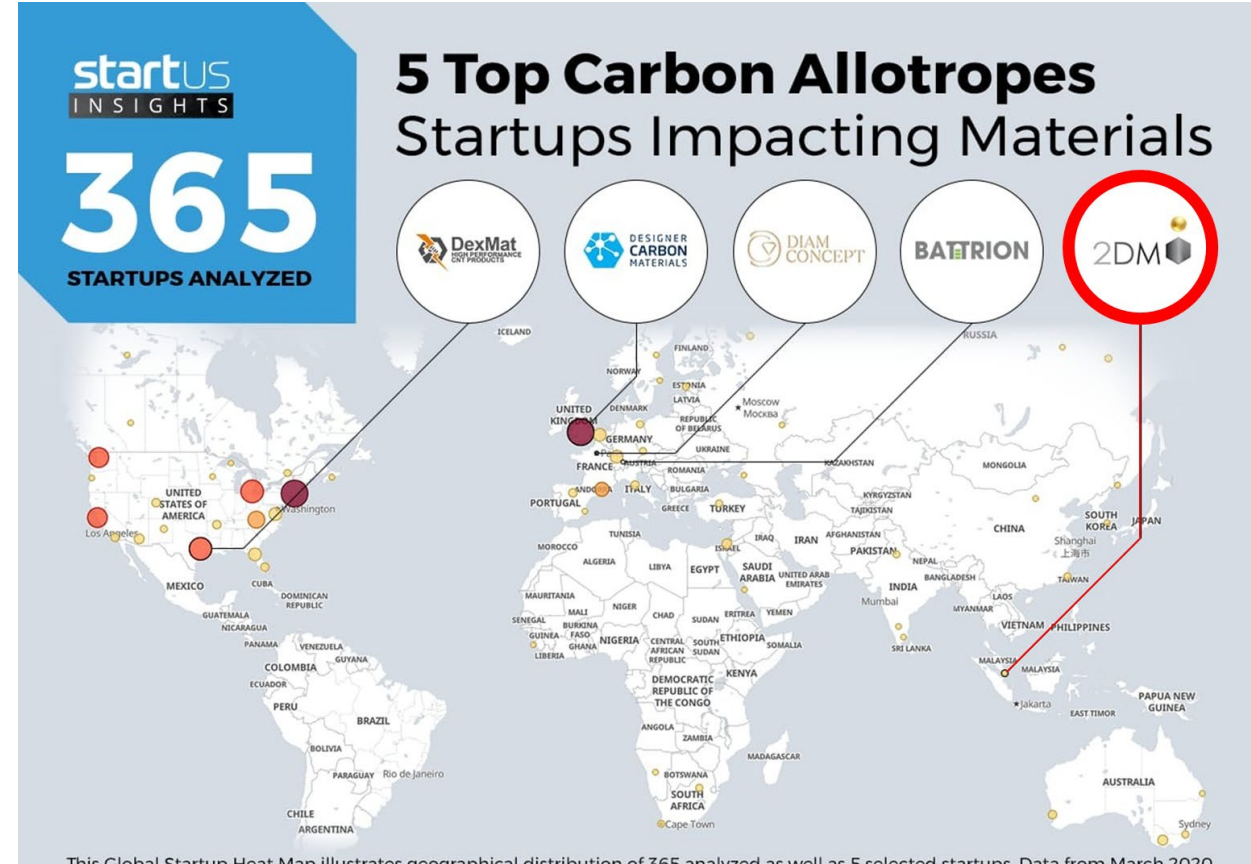


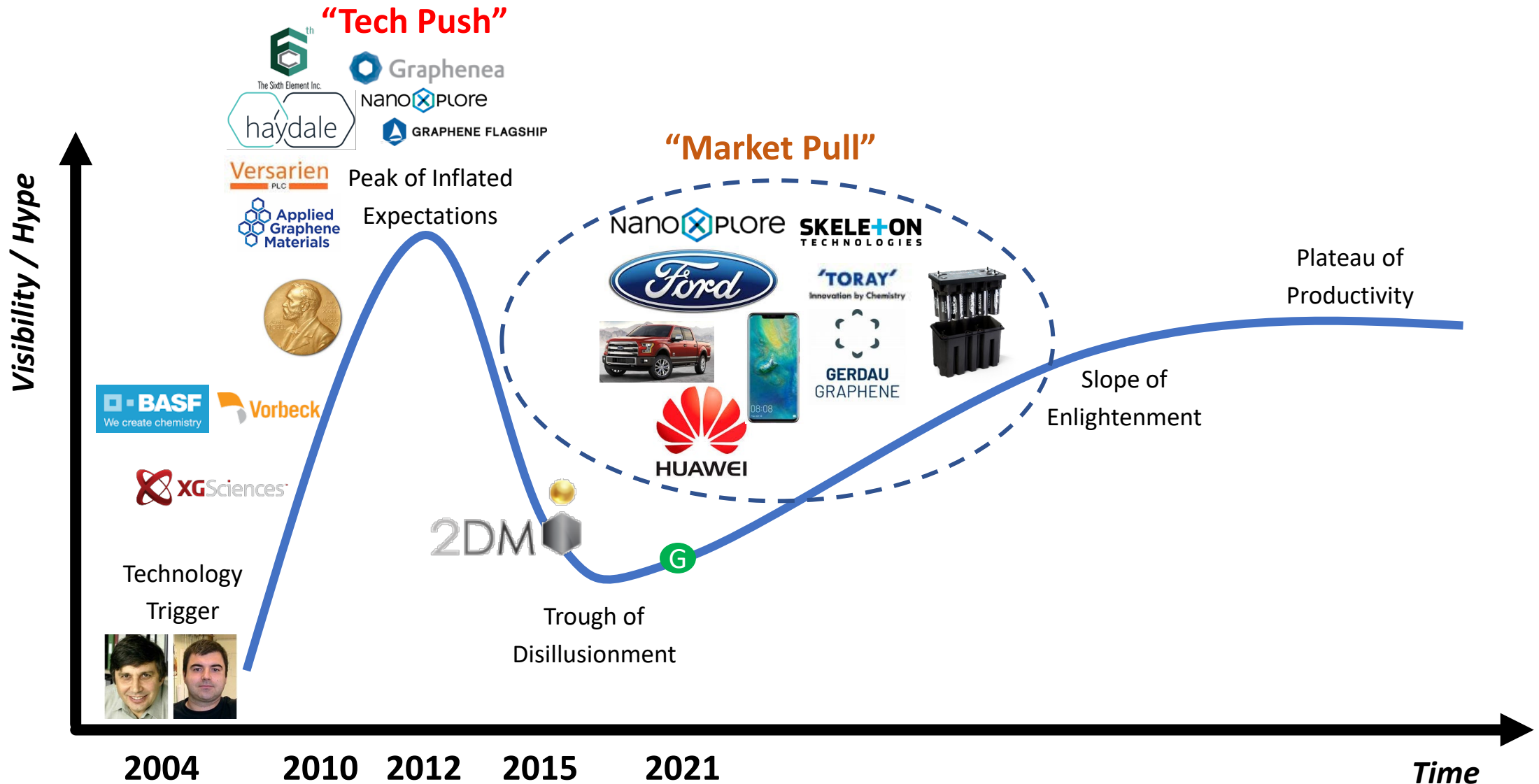
Member of:



Confidential

2DM's Awards

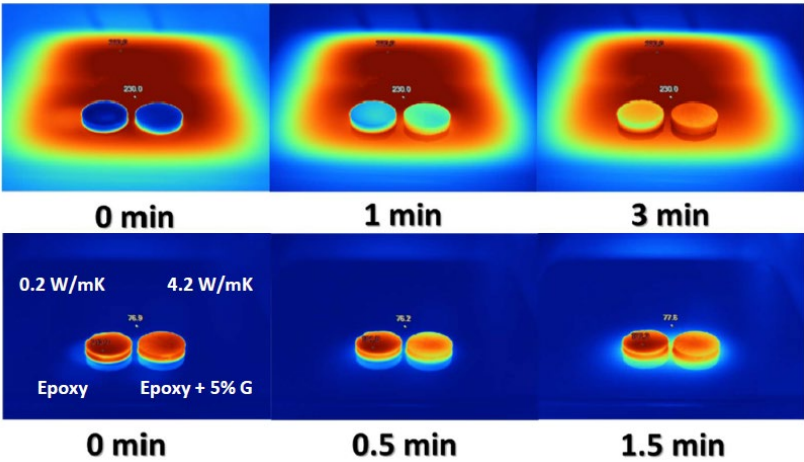




G = Graphene current position

Problems we want to solve

Thermal Conductivity



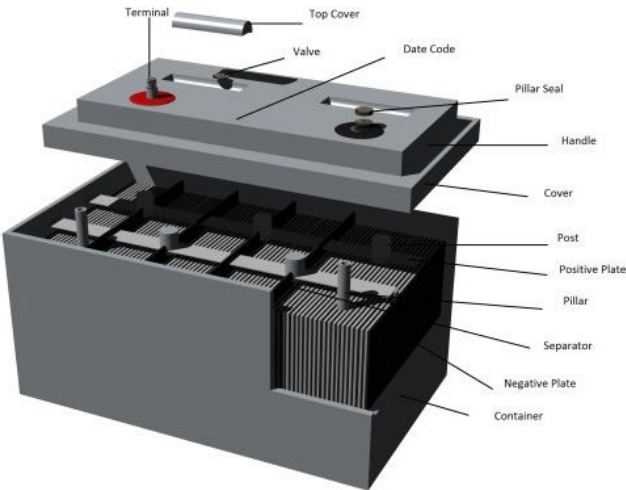
Weight Reduction



Sound Absorption



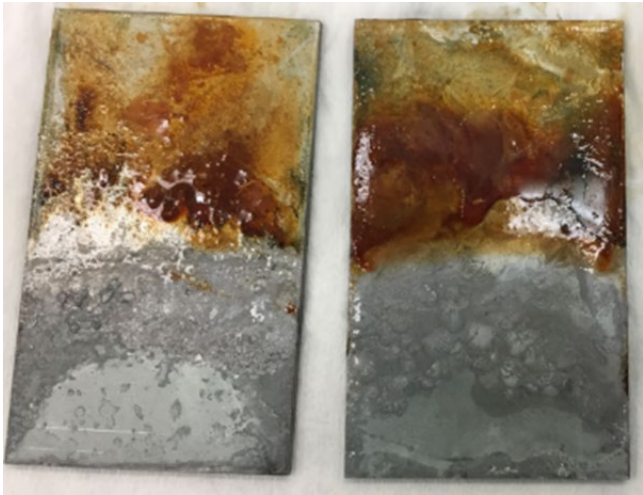
Electrical Conductivity



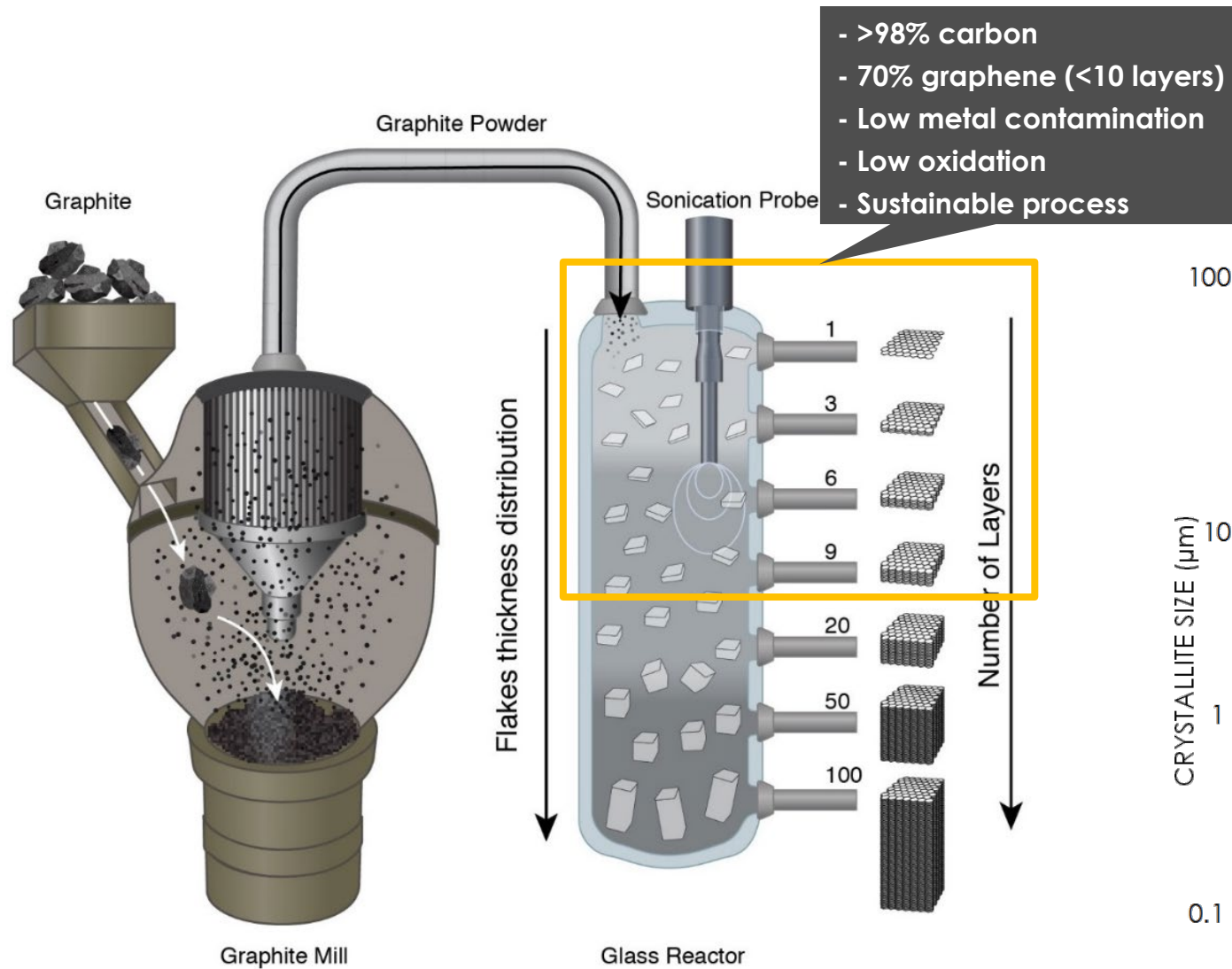
Mechanical Strength



Corrosion



2DM's Technology: what is different from others?



High Quality Graphene at High Yield, which might be translated into the best **Performance/Cost**

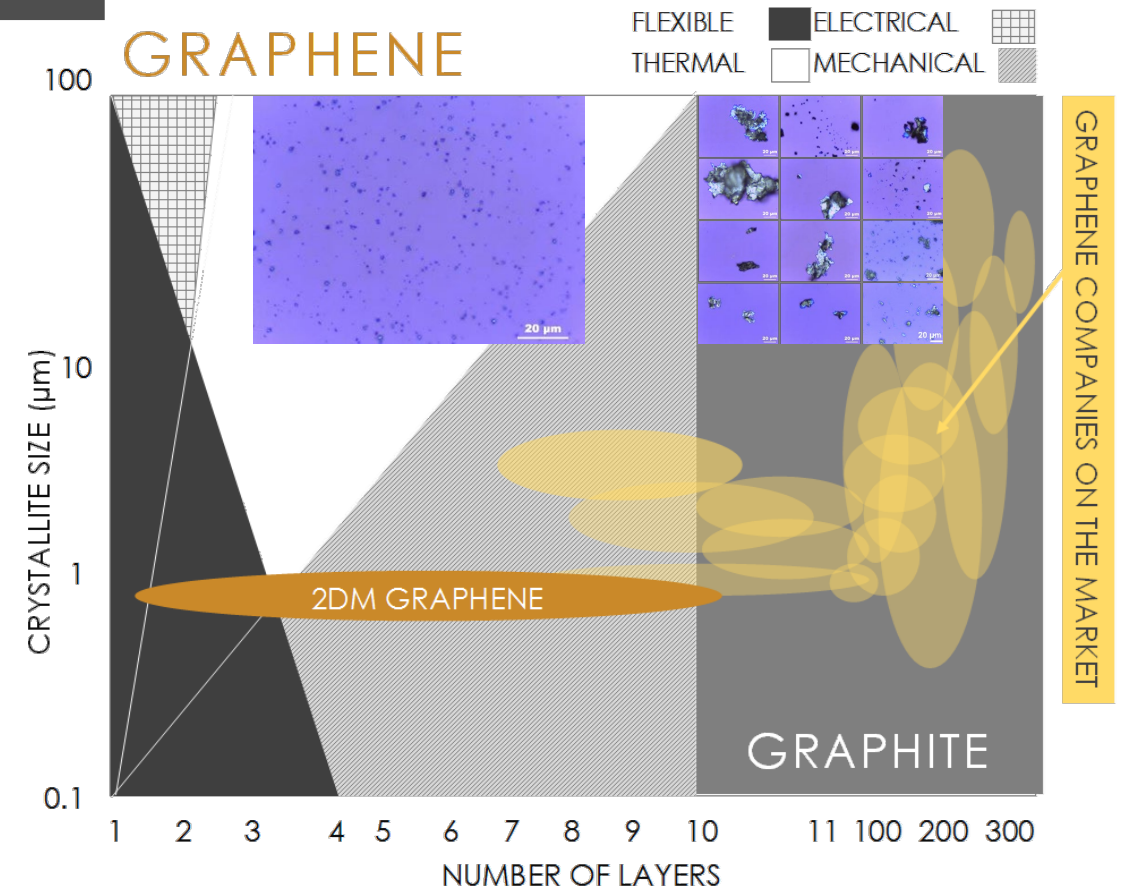


Image from Kauling et al, Advanced Materials, 2018

Confidential

Under new ISO standards up to 10 layers can be called "graphene material" >10 layers is micro-graphite

2DM's Technology: what is different from others?

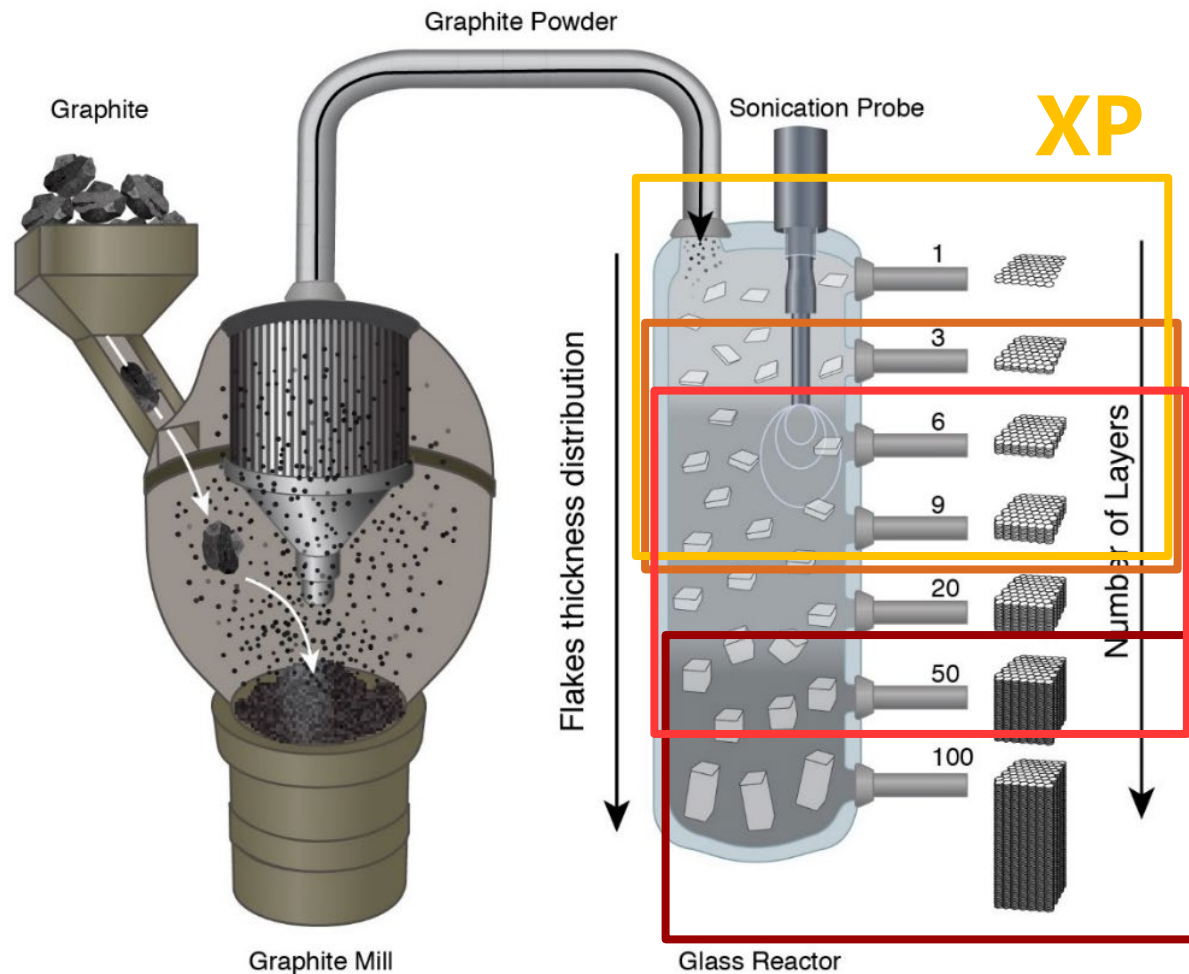


Image from Kauling et al, Advanced Materials, 2018

Applications

Sensors /
Printed Electronics

Batteries / Medical

Composites / Coatings

Concrete / Aluminum

Benefits

3x more sensitive magnetic
sensors

4x longer lasting and
2x faster charging batteries

1/2 weight composite
structures
3x longer lasting corrosion
protection
1/2 Antifouling

10x more resistance
concrete against sewage
corrosion
3x more resistance
aluminum

Confidential

2DM Production Facility




- **Commercial scale facility** established in Singapore with **12 tons capacity** per annum
- Trade secret **exclusively licensed** from NUS
- Development and implementation of new **Singapore Standards on Graphene** which will form part of **ISO/TC 229 on Nanotechnologies**
- **ISO9001: 2015 Certified**







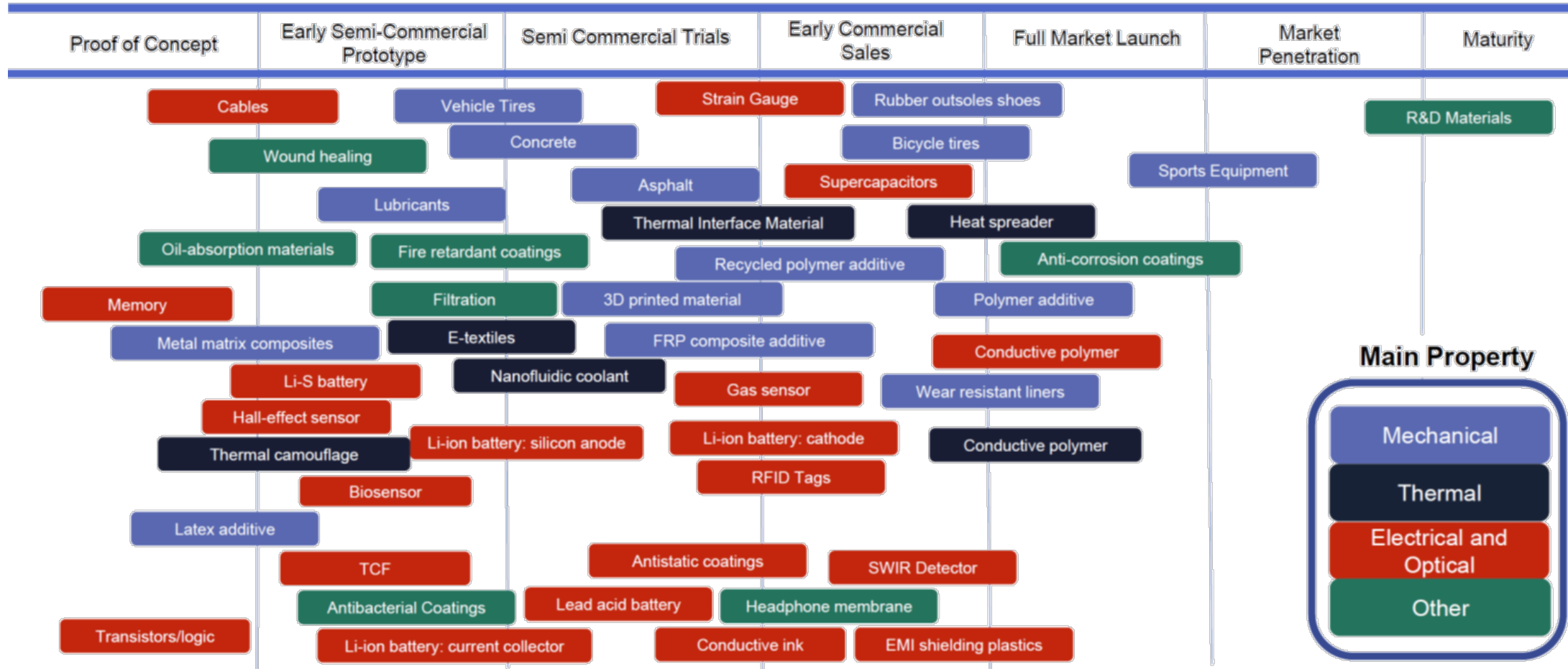


**100% of 2DM's Graphene Products are
Quality Control Checked according
ISO and Singapore Standards**



Graphene applications going commercial?

IDTechEx Research





Real Graphene Products



Confidential

Composites

A black and white photograph of a composite material, possibly a carbon fiber or Kevlar, showing a woven texture. A curved, metallic-looking structure is visible on the left, and a complex, angular, metallic structure is on the right.



Composites: Ballistic Helmet with 2DM Graphene

Composites: Ballistic Helmet with 2DM Graphene



LABORATORY TEST REPORT

NIJ STANDARD FOR BALLISTIC HELMETS 1981
NIJ STANDARD 0106.01 PENETRATION TEST
Document Revision 3 - November 2020 - Issued by B. Eu



Date Received
Counter
Sample Designation
Purchase Order

Nov-20
Client
Helmet
Not Supplied

Job No.
Test Date
Client
Report No.
Page No.

6737-20
02-Dec-20
Tristan Alexander
6737-20
2 of 2

HELMET DETAILS

Sample No./ID
Manufacturer
Project Details
Model No.
Serial No.
Batch No.
Date of Manufacture
Size
Weight (g)

6737-20-2
The Smart Think
R&D
Graphene Aramid 7.25 kg/m
Not Supplied
Not Supplied
Nov-20
Not Supplied
Not Supplied
7.25 kg m²

BALLISTIC THREAT

Calibre
Projectile Weight
Projectile Type
Cannister Markings
Production Factory
Head Stamp Details
Barrel Length
Barrel Serial No.
Caliber
Specification
Required Velocity

9mm Luger
124 grain
FMJ RN
WB9MC124 2EH22
Winchester
Not Applicable
10 inch
M34917-8
Zero Degrees
NIJ0106.01 Lvl1a Spec
436 ± 9 m/s

RANGE

Muzzle to Target
No. of Screens
Screen Spacing
Midpoint to Target
Chronograph Model
Screen Type
Screen Light Source

5 metres
3
5.0 ft
2.0 metres
Sibre Iris
Skyscreen 408
DC LED

TEST CONDITIONS

Temperature
Relative Humidity
Conditioning

21.1 °C
46.2 %
Ambient

CLIENT DETAILS

Tristan Alexander
The Smart Think
75 Pigdon Rd
Waurim Ponds, VIC 3216
Australia

APPLICABLE STANDARDS/PROCEDURES

NIJ Standard 0106.01
1. Witness Material
2. Witness to Target
3. Clay Verification

TEST PERSONNEL

Data Recorder
Gunner
Witness

B. Kelaart
B. Kelaart
NI

Sample Number	Impact Plane	Yaw	Shot No.	Velocity Chrono 1 (m/s)	Velocity Chrono 2 (m/s)	Velocity Average (m/s)	Notes	Panel Pen.	Spalling	BFS (mm)	Pass/Fail
6737-20-2	Crown	Nil	1	437.3	436.4	436.9		Nil		3mm	Pass
	Mid-Sagittal	Nil	2	432.5	431.7	432.1	Front	Nil		14mm	Pass
	Mid-Sagittal	Nil	3	434.2	433.6	433.9	Back	Nil		12mm	Pass
	Coronal	Nil	4	437.4	436.0	436.7	Right	Nil		8mm	Pass
	Coronal	Nil	5	436.3	437.1	437.7	Left	Nil		8mm	Pass

Footnotes:

- Excessive velocity
- Insufficient velocity
- Too close to prior impact
- Too close to edge
- Test terminated
- Not a fair hit

Comments:

1. Nil

Deviations From Standard:

1. Nil

B. Eu
(Approved signatory)

Sample Compliance
Passed: Yes

Postal address: 100 Turner St, Port Melbourne 3207
Victoria, Australia. ABN: 72 097 157 607
Phone: +61 3 9646 4211. Fax: +61 3 9646 9883
Email: ben@armourtesting.com



Accreditation Number: 13310
Accredited for compliance with ISO/IEC 17025 - Testing



LABORATORY TEST REPORT

PROTECTION - BALLISTIC LIMIT (V50 BL(P))
MIL-STD-662F DECEMBER 1997
Document Revision 3 - March 2015 - Issued by H.Bul



CLIENT DETAILS

Tristan Alexander
The Smart Think
75 Pigdon Rd
Waurim Ponds, VIC 3216
Australia

Date Received
Counter
Sample Designation
Purchase Order

Oct-20
Client
Helmet
Not Supplied

Job No.
Test Date
Client
Report No.
Page No.

6681-20
30-October-2020
Tristan Alexander
6681-20
3 of 5

ARMOUR DETAILS

Sample No./ID
Manufacturer
Project Details
Panel Model No.
Panel Serial No.
Panel Batch No.
Date of Manufacture
Sitting Details
Sitting Intervals
Panel Description
Average Thickness
Nominal Hardness
Heat Number

6681-20-3
The Smart Think
R&D
7.25 kg/m² Aramid Graph
Not Supplied
Not Supplied
Not Supplied
Not Supplied
Not Applicable
Not Applicable
Ballistic Helmet
Not Applicable
Not Applicable
Not Applicable

BALLISTIC THREAT

Calibre
Projectile Weight
Projectile Type
Cannister Markings
Production Factory
Head Stamp Details
Barrel Length
Barrel Serial No.
Caliber
Specification
Required Min. BL

22 FSP
17 grams
FSP
Not Applicable
Not Applicable
Not Applicable
24 inch
V08001
Zero degrees
MIL-STD-662F
Not Supplied

RANGE

Muzzle to Target
No. of Screens
Screen Spacing
Midpoint to Target
Chronograph Model
Screen Type
Screen Light Source

12.5 ft
3
5.0 ft
5.0 ft
Sibre Iris
Skyscreen 408
DC LED

TEST CONDITIONS

Temperature
Relative Humidity
Conditioning

21.4 °C
52.8 %
Ambient

APPLICABLE STANDARDS OR PROCEDURES

- MIL-STD-662F
- Sample to Witness: 150mm
- Witness Material: 0.5mm T2 2024 Alloy
- Examination Light: 60W Light bulb

TEST PERSONNEL

Data Recorder
Gunner
Witness

Ben Kelaart
Ben Kelaart
NI

BALLISTIC LIMIT FIRING DATA										BASELINE BALLISTIC LIMIT CALCULATION									
Shot No.	Charge (gr)	Vel. 1 (m/s)	Vel. 2 (m/s)	Impact Velocity m/s	Penetration C	P	Remarks	Used (Y/N)	Shot No.	Vel. (m/s)	Penetration C	P	Ballistic Limit Summary						
1	7.5	713	698	695	X			Y	1	695	X		Type: 10 Shots Panel 1 BL: 673 m/s Velocity Range: 36 m/s Standard Deviation: 13 m/s Gap: -12 m/s						
2	7.5	702	689	675	X			Y	2	675	X								
3	7.5	697	684	671		X		Y	3	671		X							
4	7.5	696	674	661	X			Y	4	661									
5	7.5	719	704	692	X			Y	5	692	X								
6	7.5	708	694	681		X		Y	6	681		X							
7	7.5	732	717	705	X			N											
8	7.5	684	671	658		X		Y	8	658		X							
9	7.5	679	666	654	X			Y	9	654		X							
10	7.5	709	694	682	X			Y	10	682	X								
11	7.5	695	682	669	X			Y	11	669	X								
Count:		11	6	5				10	Count:	10	5	5							

FOOTNOTES:

- Too close to edge
- Too close to prior impact
- Impact on seam

COMMENTS:

1. Nil

B. Eu
(Approved signatory)

Sample Compliance
Passed: N/A

Postal address: 100 Turner St, Port Melbourne 3207
Victoria, Australia. ABN: 72 097 157 607
Phone: +61 3 9646 4211. Fax: +61 3 9646 9883
Email: ben@armourtesting.com



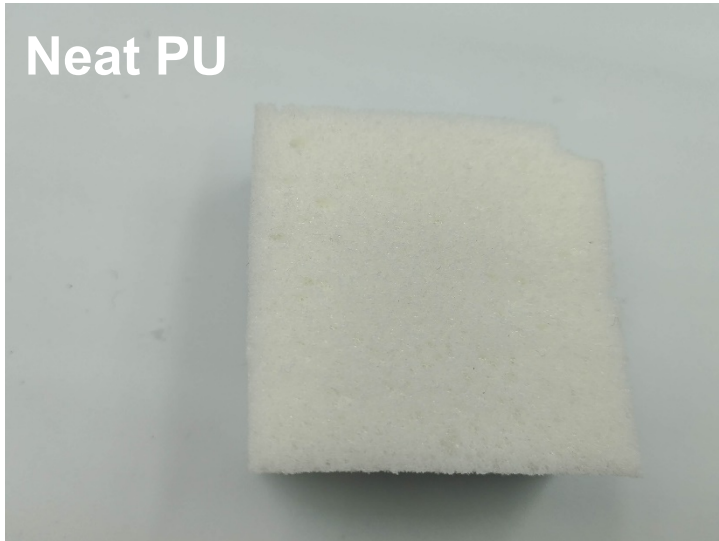
Accreditation Number: 13310
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.



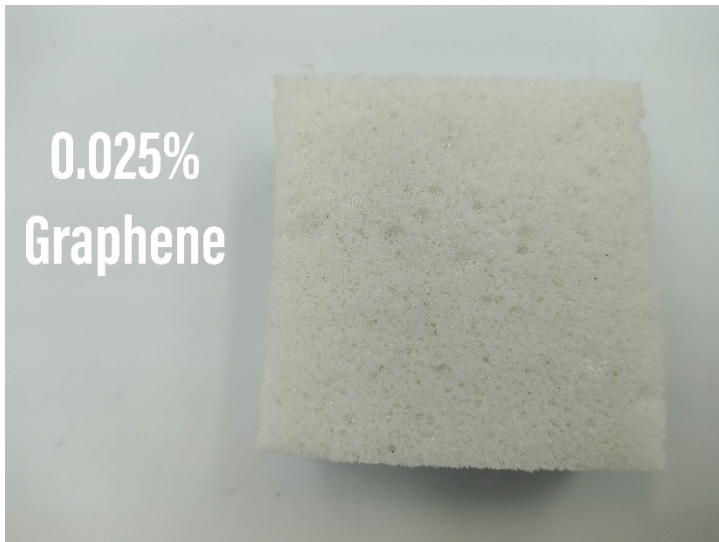
"Same ballistic protection and same price,
but **20% lighter** than standard helmets"

2DM Graphene in PU foam

Neat PU

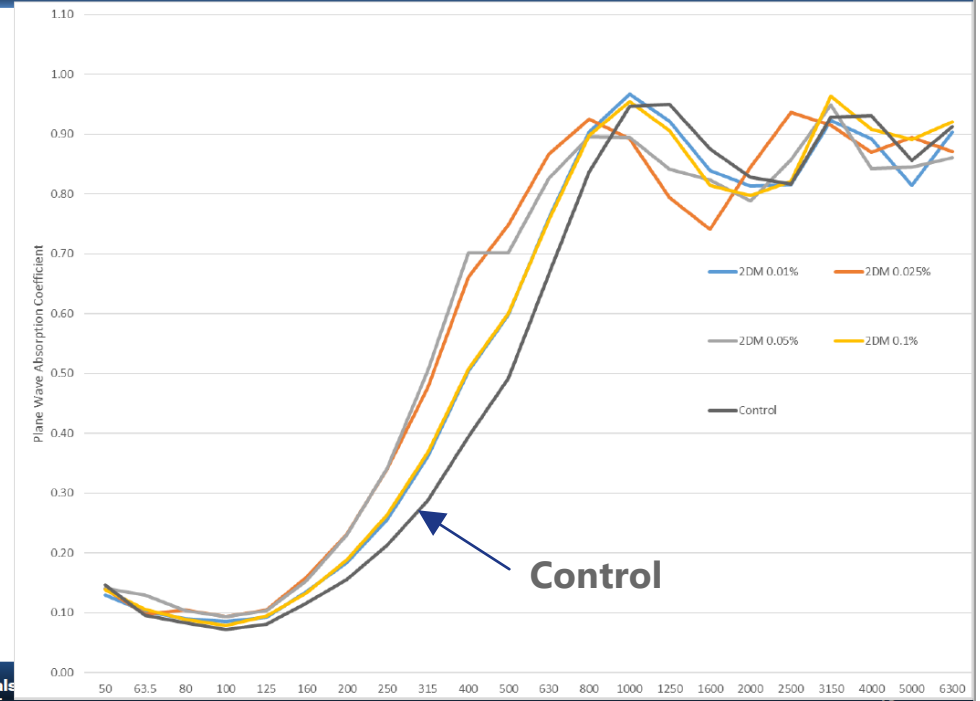


0.025%
Graphene

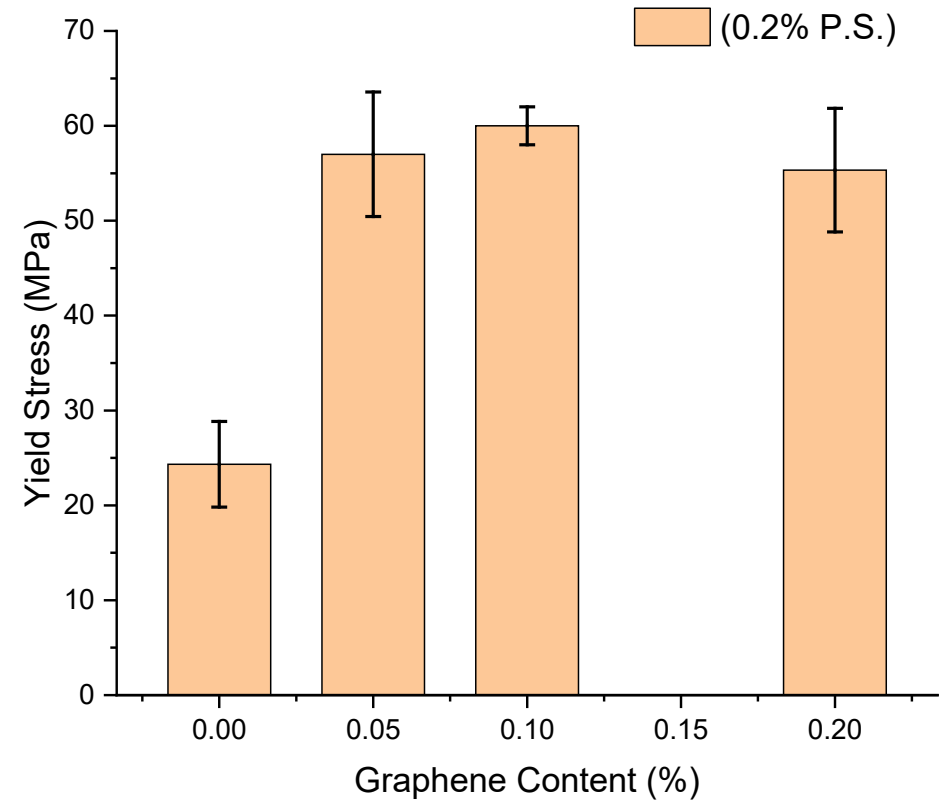
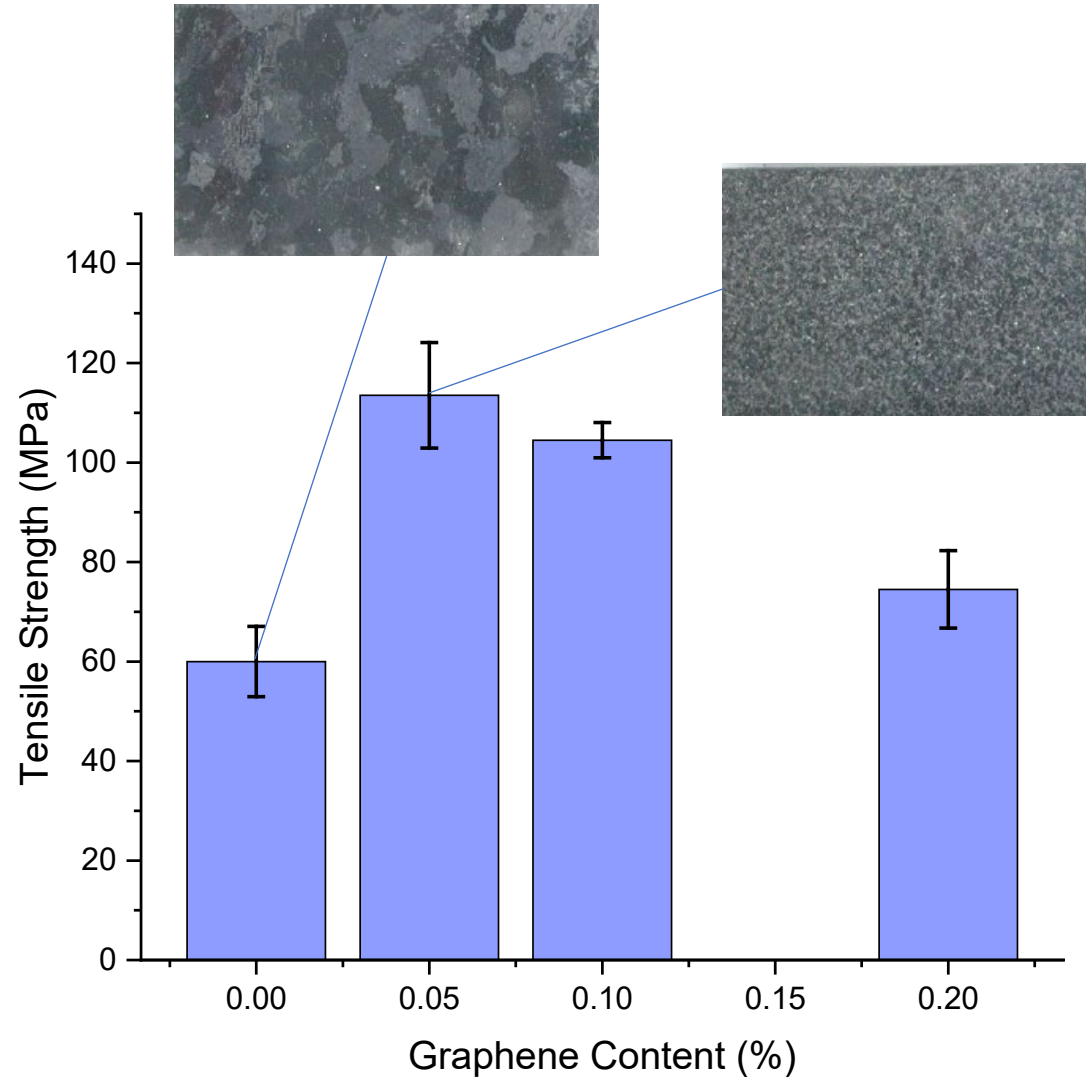


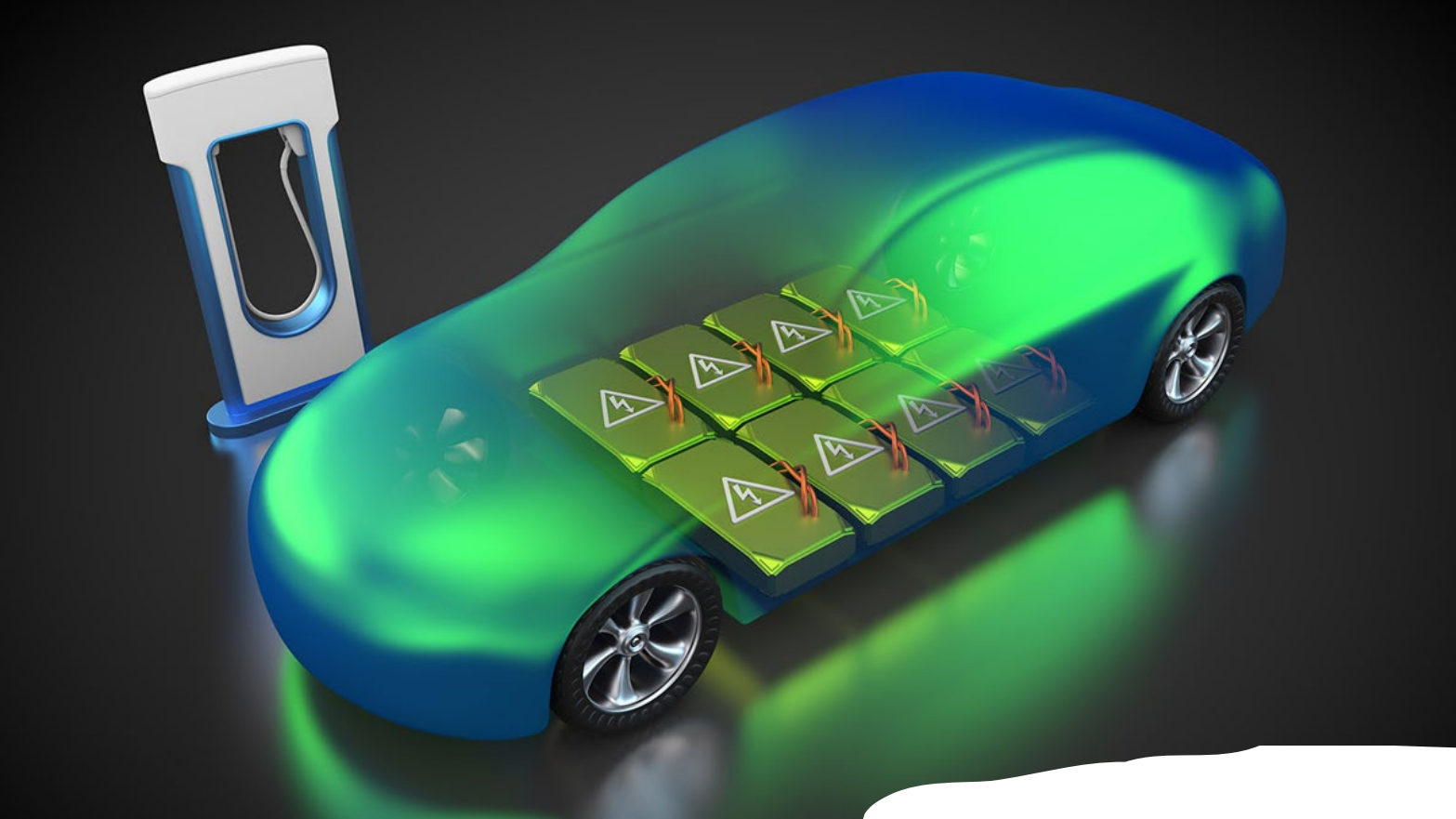
Sound Absorption

- Improvement at all loadings up to 100 Hz
- 2000-5000 Hz range is most sensitive to human ear



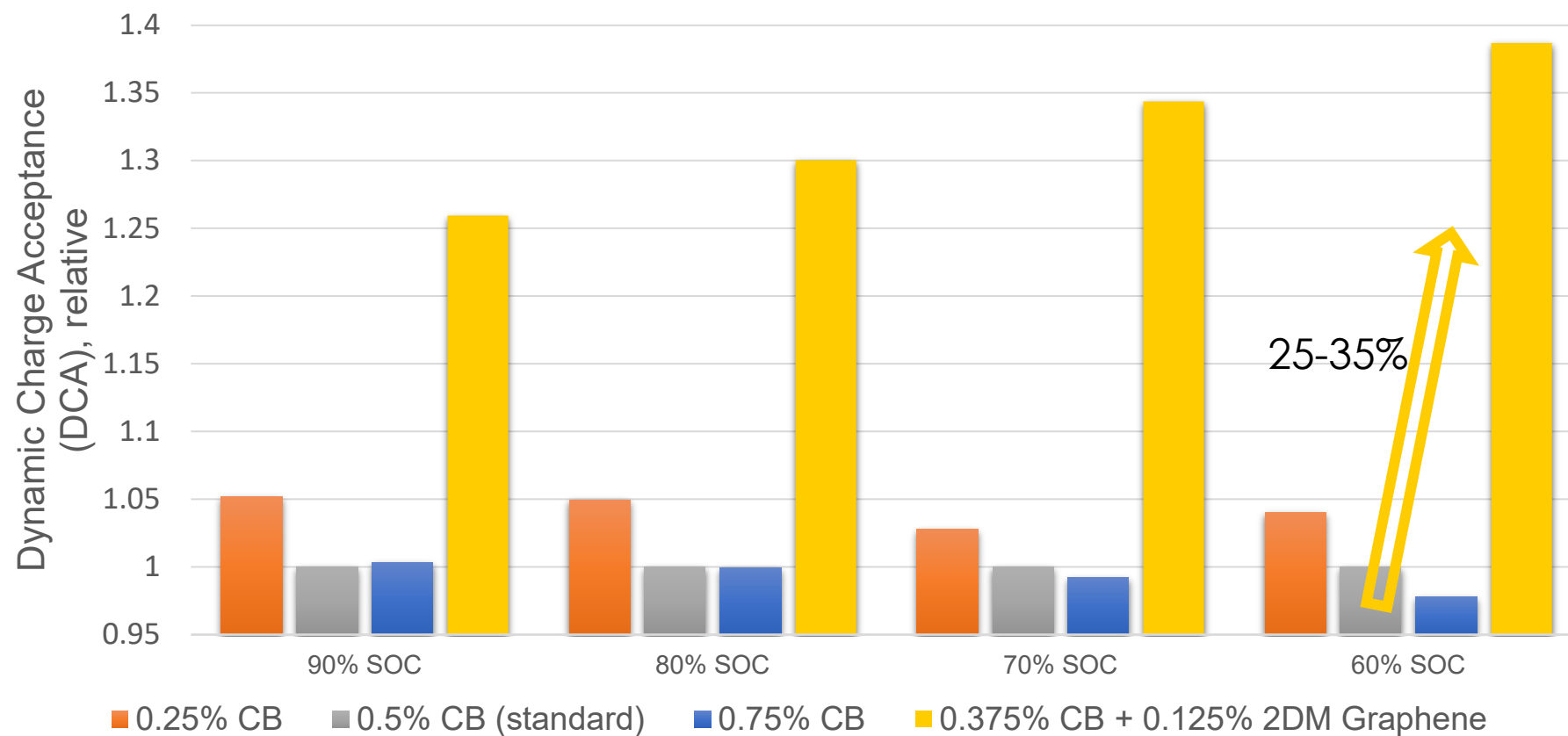
Aluminium + 2DM Graphene





Batteries & Supercaps

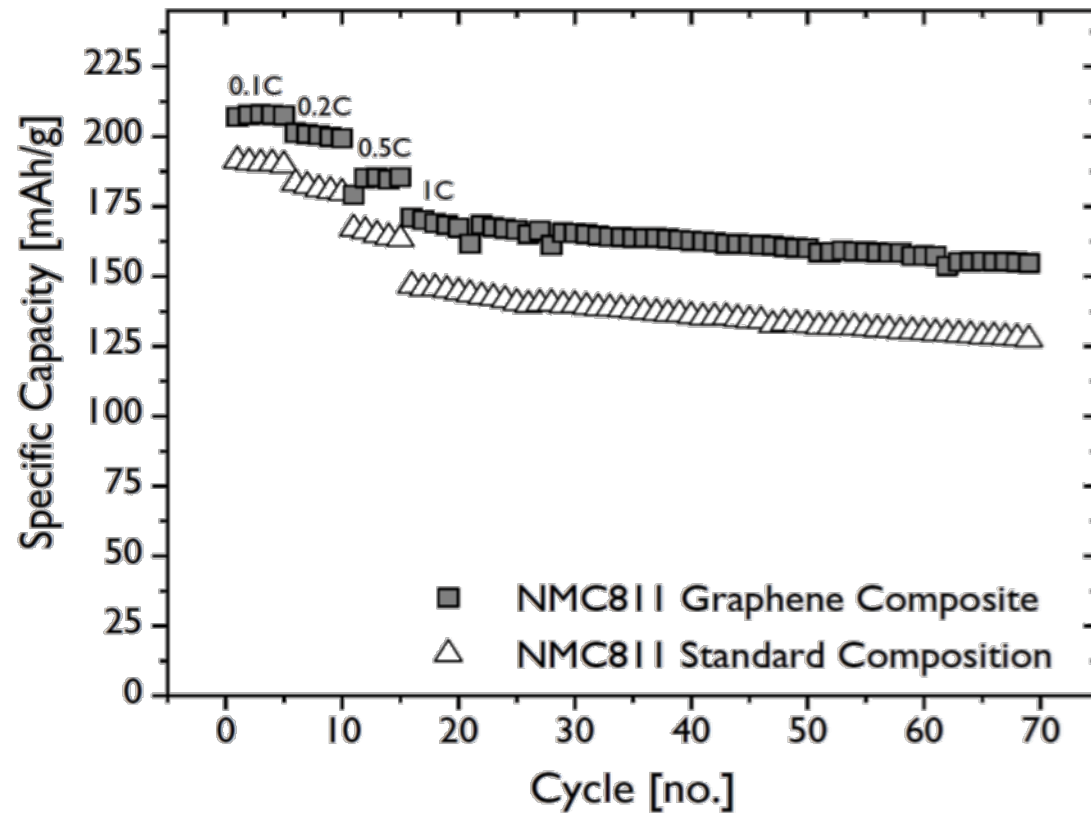
2DM Graphene in Lead Acid Battery



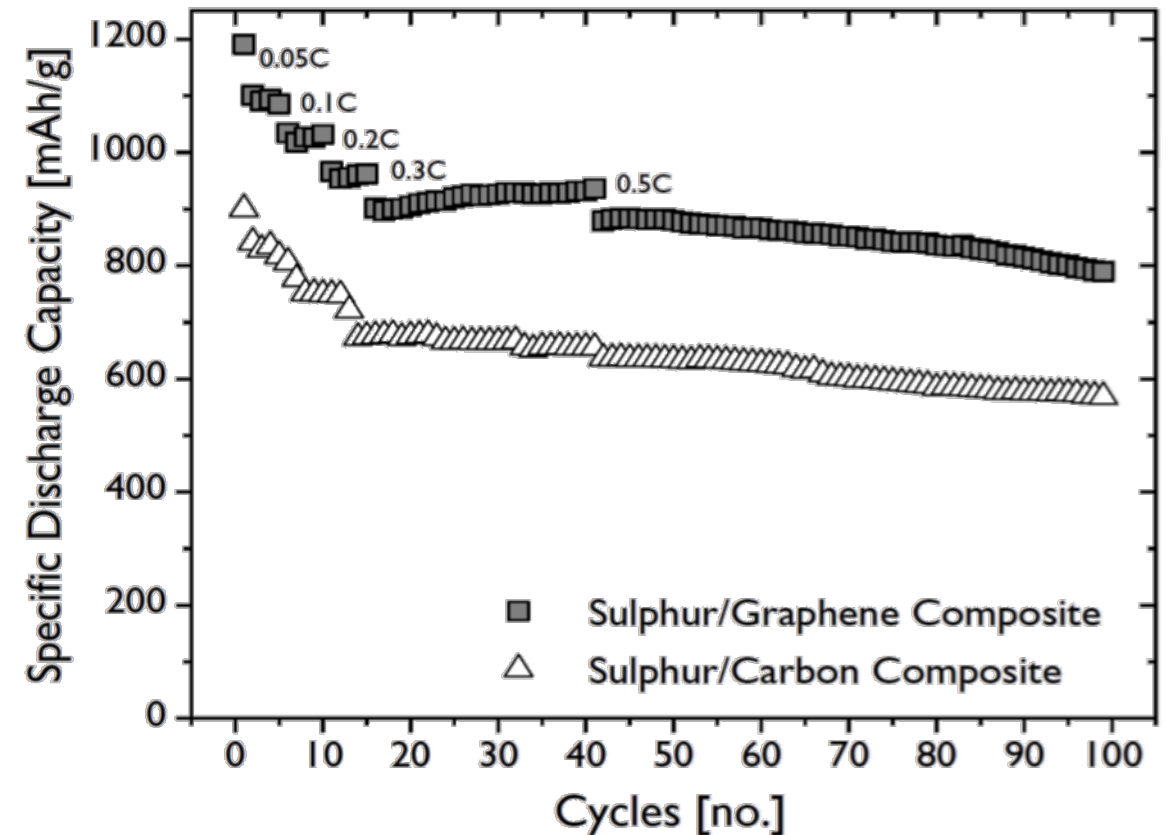
CB = Carbon Black

2DM Graphene in Li Batteries

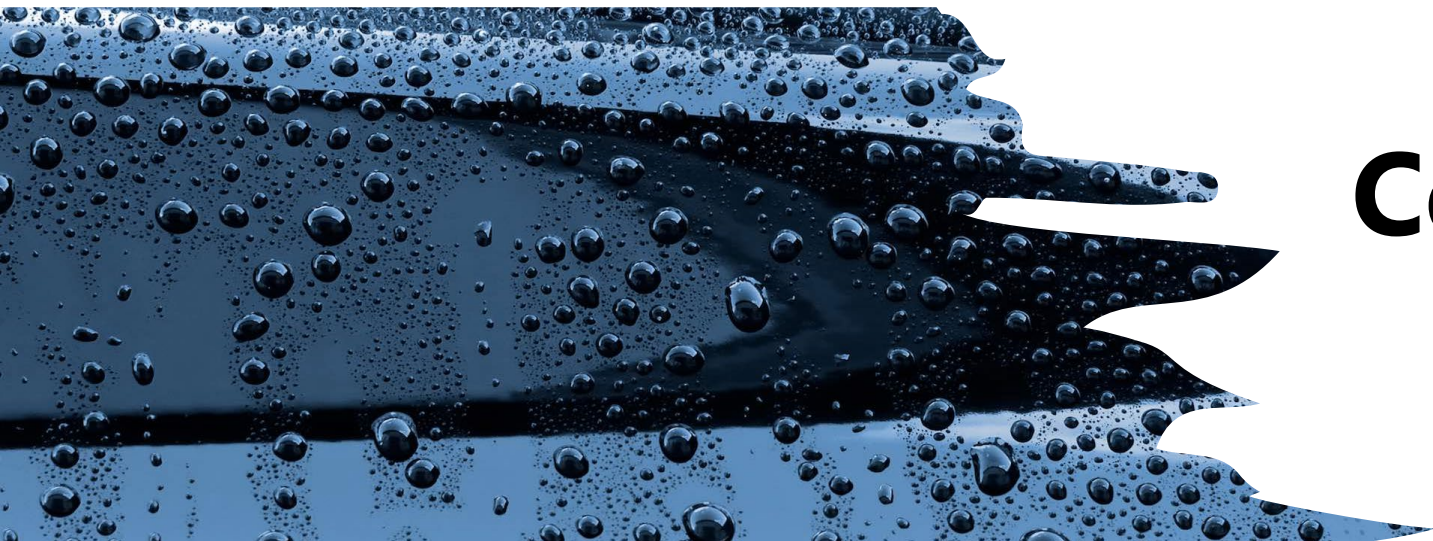
Li-Ion Batteries



Li-S Batteries



“Faster Charging, longer lasting, and superior durability”

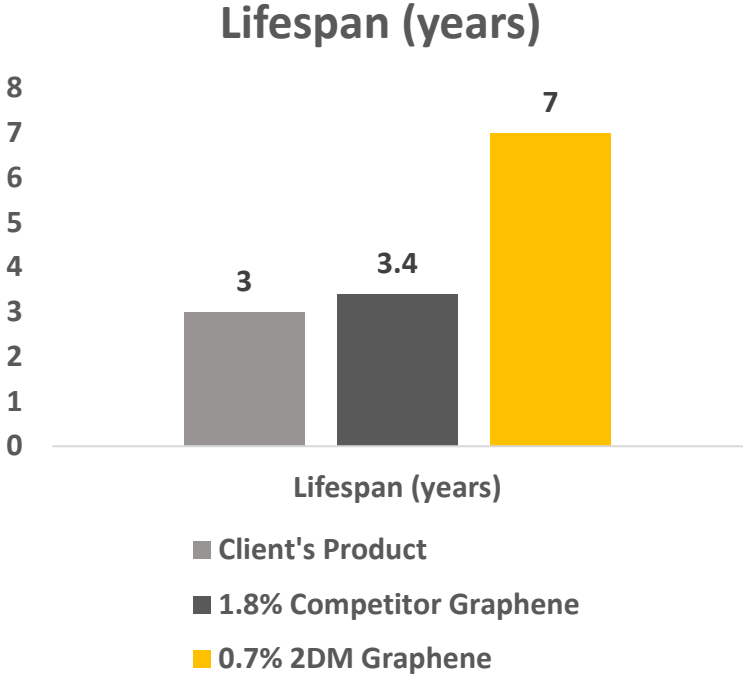
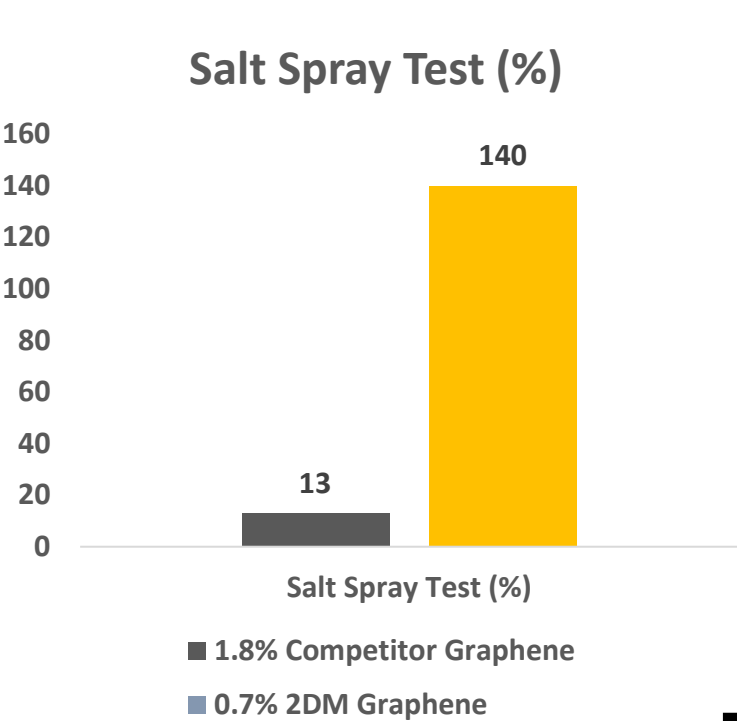


Coatings & Paints

2DM's Graphene in Coatings



Results obtained by **one of the largest** global Paints & Coatings **manufacturer**



Potential savings of US\$ 6 million per ship every 5 years

Properties (Potential)	Client's Product	1.8% Competitor Graphene	0.7% 2DM's Graphene
Anti-fouling effect	None	None	High
Drag resistance	Standard	Standard	Low

Graphene Direct-To-Metal (DTM) Anti-Corrosion coating samples

Standard coating



Before

After

Delamination

*Standard coating
+ graphene*



Before

After

Delamination

*Standard coating
+ graphene*



Before

After

Delamination

*Standard coating
+ graphene*



Before

After

Delamination

Cyclic Corrosion test (ISO20340) 25 cycles

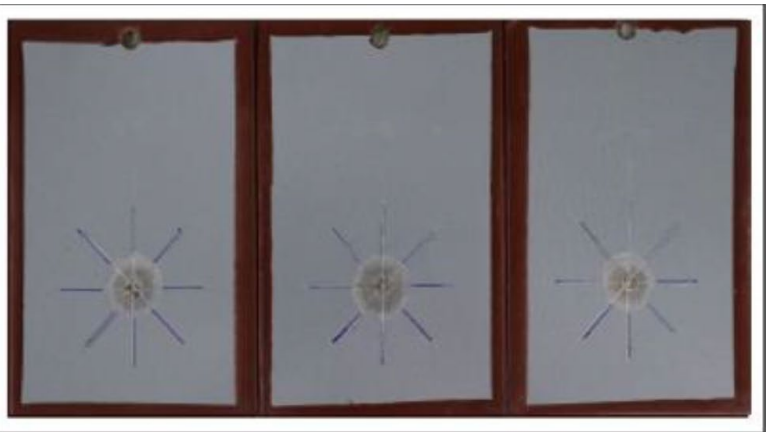
Graphene Direct-To-Metal (DTM) Anti-Corrosion coating samples



Standard coating



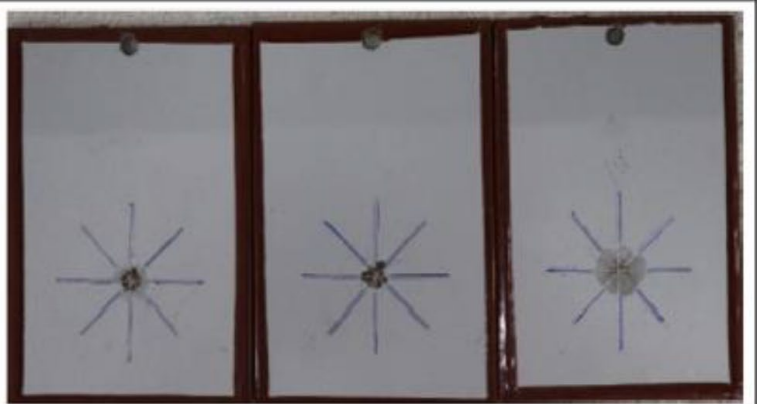
*Standard coating
+ graphene*



Cathodic disbonding (720 hours)



*Standard coating
+ graphene*



*Standard coating
+ graphene*

Other Anti-Corrosion systems

Standard coating



*Standard coating
+ graphene*



*Standard coating
+ graphene*



Salt Spray (ASTM B 117) 500 hours

Other Anti-Corrosion systems

Standard coating



*Standard coating
+ graphene*



Salt Spray (ASTM B 117) 1500 hours

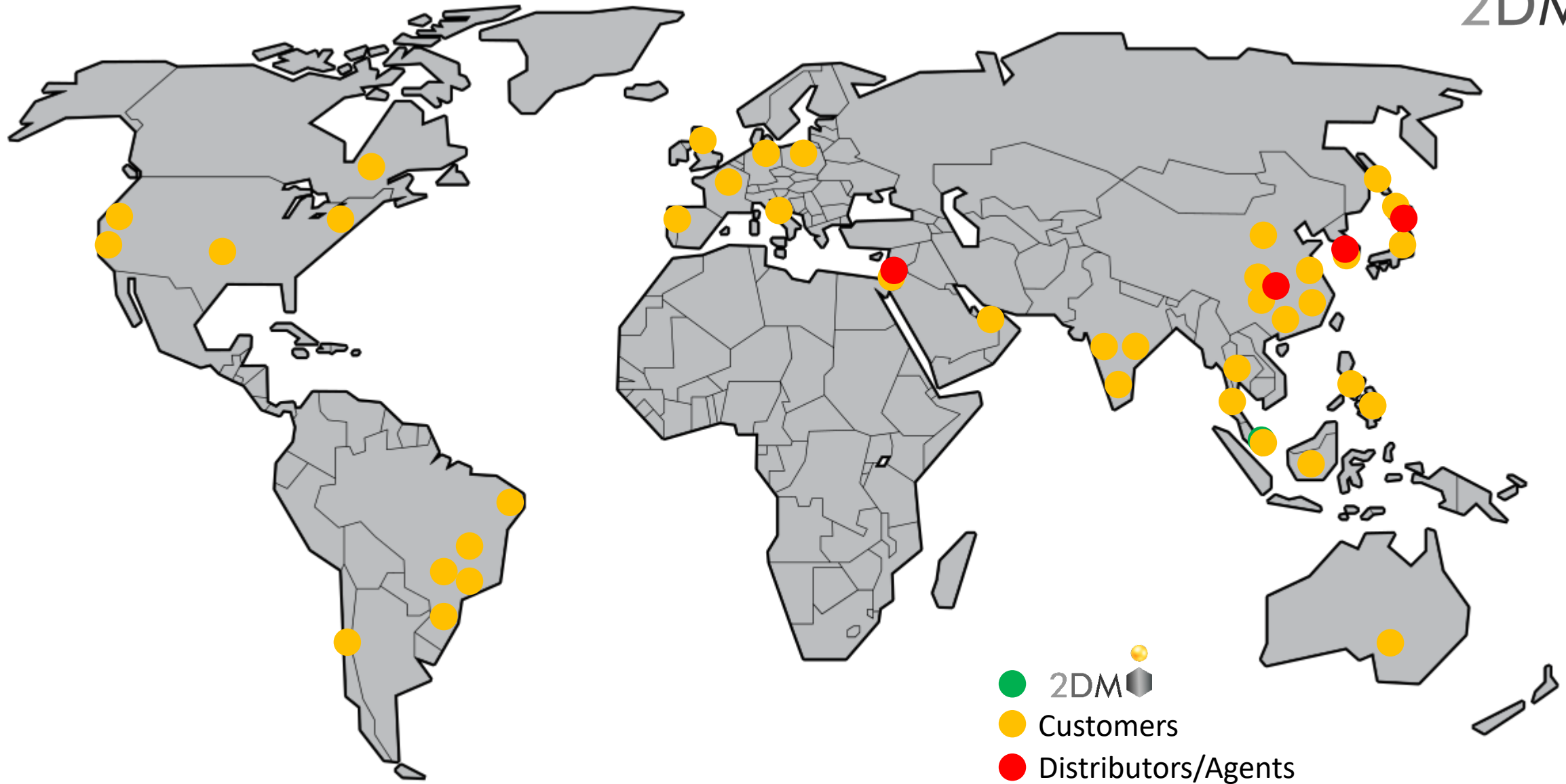




Final Remarks

- **Graphene works**, if you use real graphene
- Graphene is **not so expensive**
- **Value-added** easy to show and customer **willing to pay**
- **Technical expertise** needed to use graphene
- Exponential grow of the applications and **market products**
- **Major players** of each segment already have **graphene products** ready to launch







Obrigado! Gracias! Grazzie! Merci!
Danke Schön! Thank you! Спасибо! 감사 해요!
谢谢!! شكرا لك Terima Kasih! ありがとうございます! शुक्रिया!

Ricardo Oliveira (CTO/co-founder)
ricardo.oliveira@2dmsolutions.com

