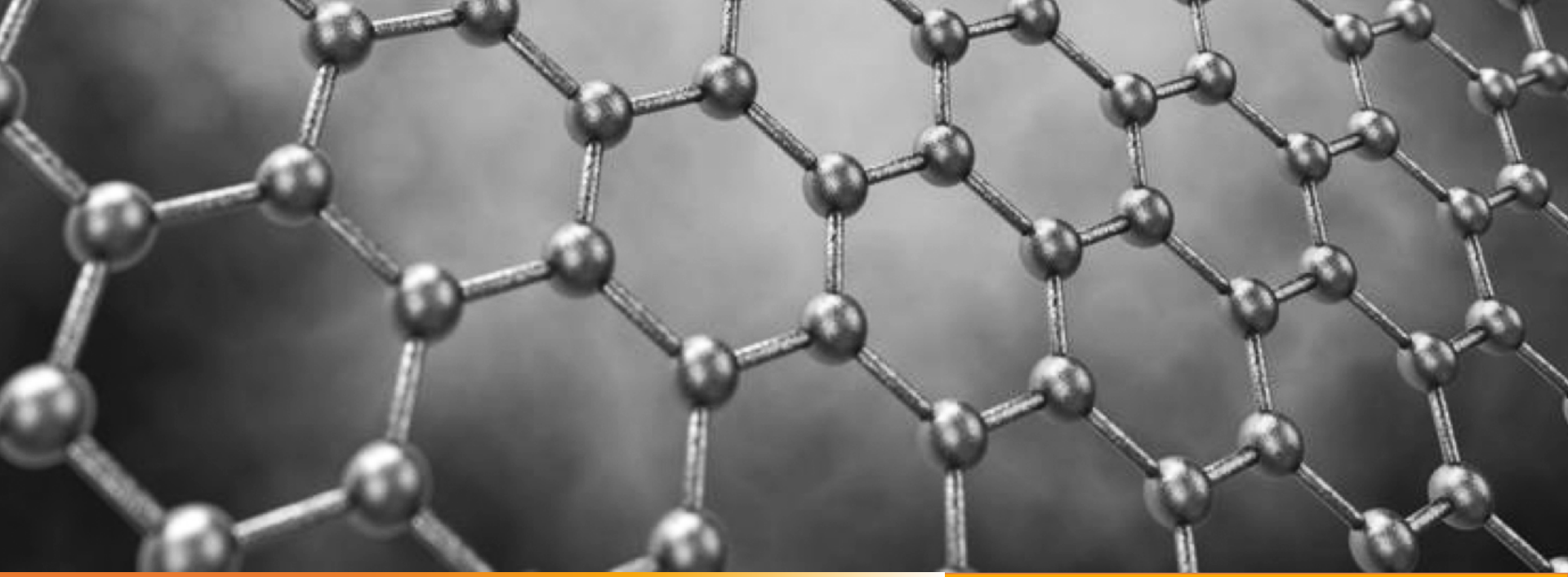

# Real World Applications In Graphene, Taking The Greatest Discovery From Manchester Into The Real World

**Neill Ricketts**
**CEO**
**Versarien/2dtech**

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# Delivering next generation advanced materials

2-DTECH
Two dimensional materials

**2-DTECH**
A spin out of the University of Manchester.
Patented process for producing high quality graphene.
Development of graphene into new materials
e.g. nanocomposites

Versarien®
Advanced
Composites

**VERSARIEN ADVANCED COMPOSITES**
New division
Address real world applications of graphene

MANCHESTER
1824
The University of Manchester

Innovate UK
Technology Strategy Board

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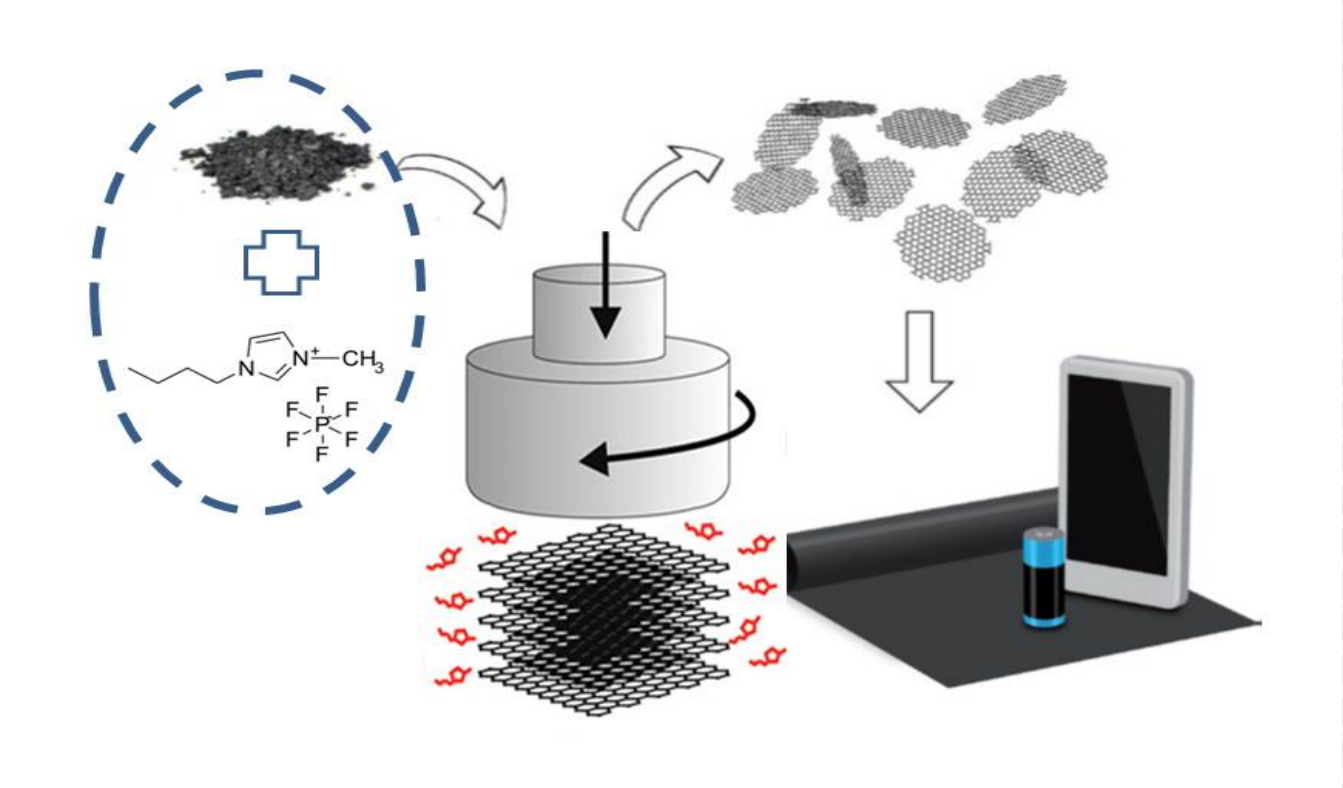
# Where and how we do this?

# 2-DTech Graphene



**Patent Refs:**
**WO2012117251**
**EP2681155**
**US2014044968**
**CN103492317**

- Proprietary licenced processes using standard industrial equipment
  Graphene nanosheets by ionic liquid assisted grinding

- High quality graphene
- Competitive product quality and cost

- Platelets, CVD graphene, graphene oxide

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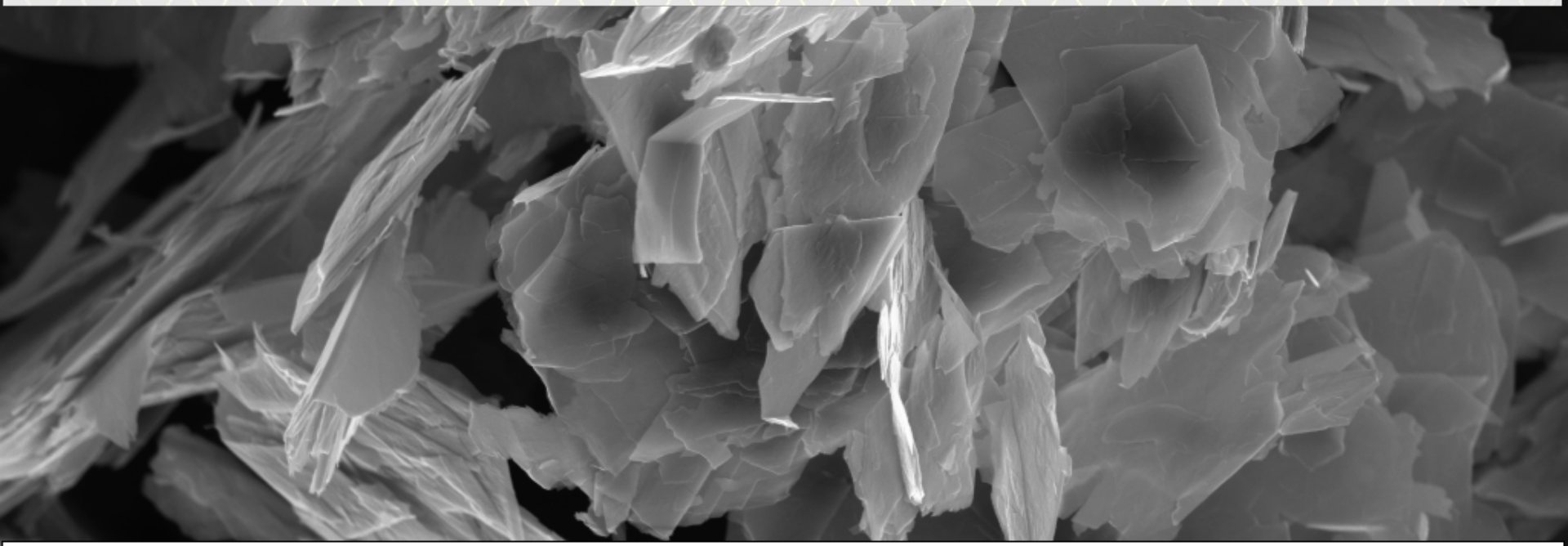
# Creating graphene

- 1-5 layers
- 2-3microns in diameter
- 98%+ purity
- Dry, in solution or compounded in master batch



# Market pressure

**Automotive**
**Aerospace**
**Marine**
**High Performance Sports goods**
**Defence**
**Luxury Consumer goods**

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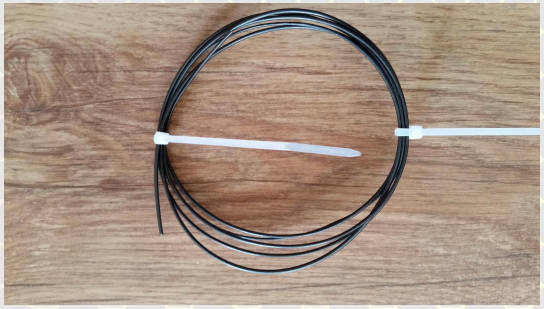
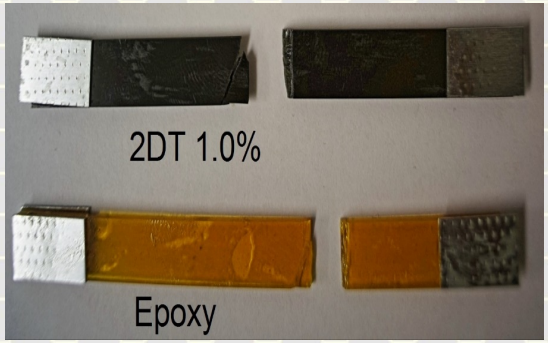
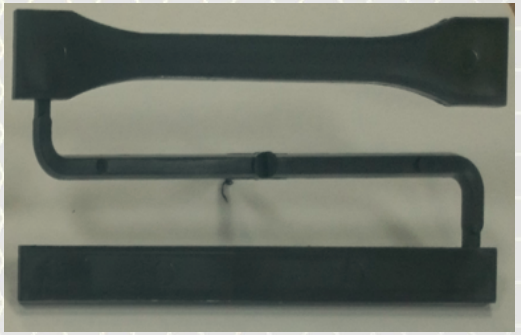
# Examples of work

- PEEK 150 graphene reinforced
- Carbon Fibre Composite
- Others to follow Silicone, Nylon, ABS, Rubbers, glass and  Metallics





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# Feasibility study into graphene-PEEK nanocomposites

**To bridge the gap that currently exists between graphene's potential and its commercial applications**

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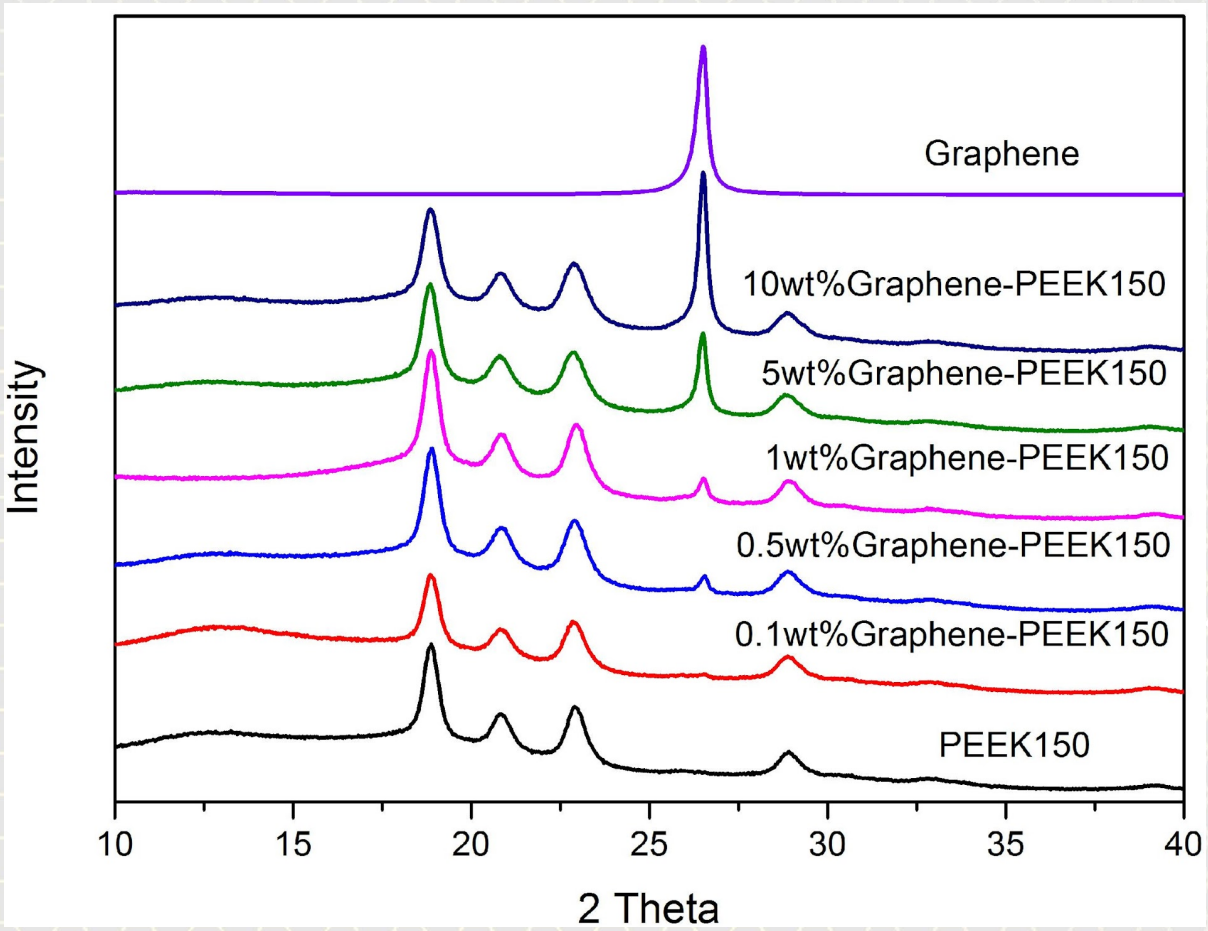
# XRD of films




1 wt% Graphene-PEEK150

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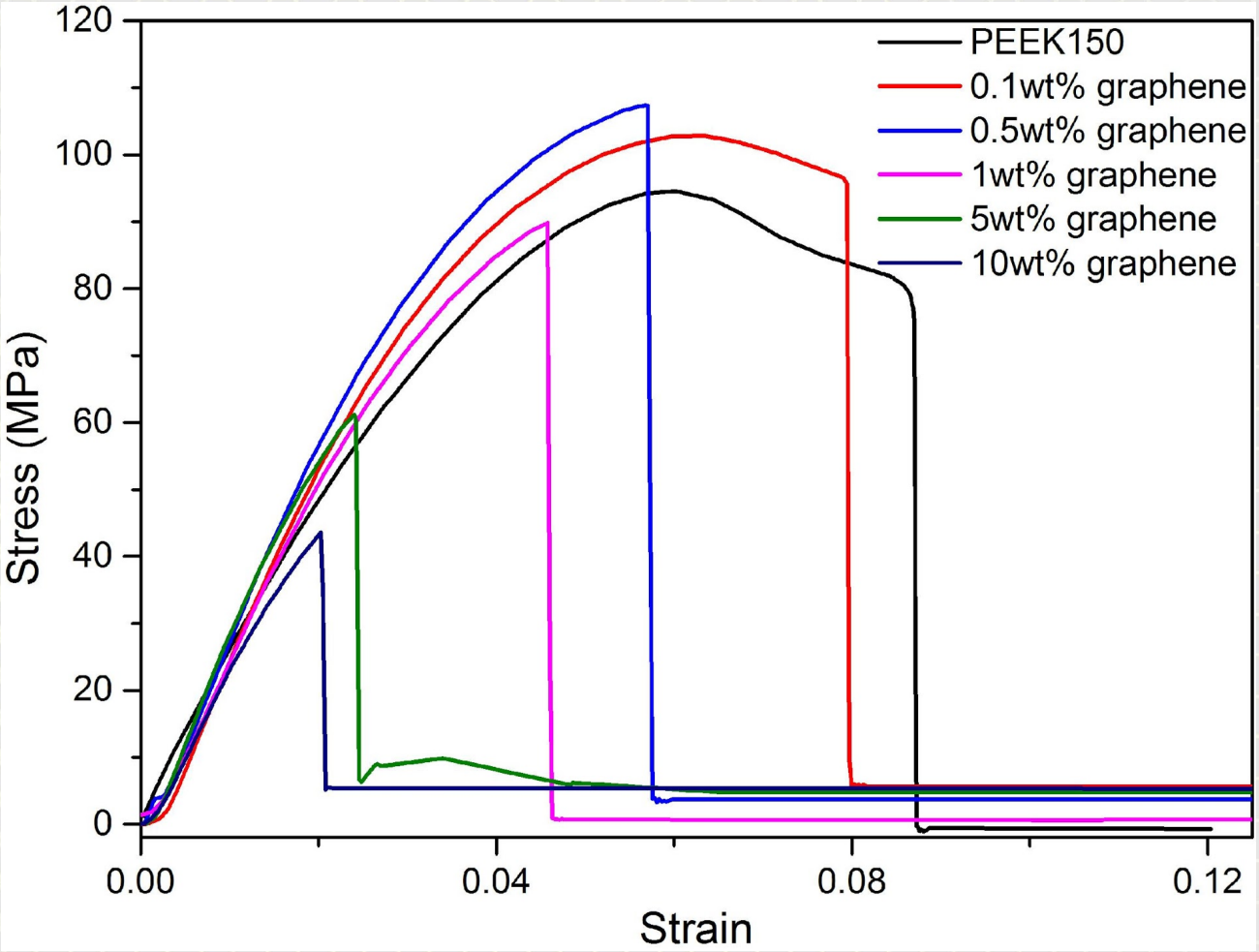
# Tensile testing – stress-strain curves

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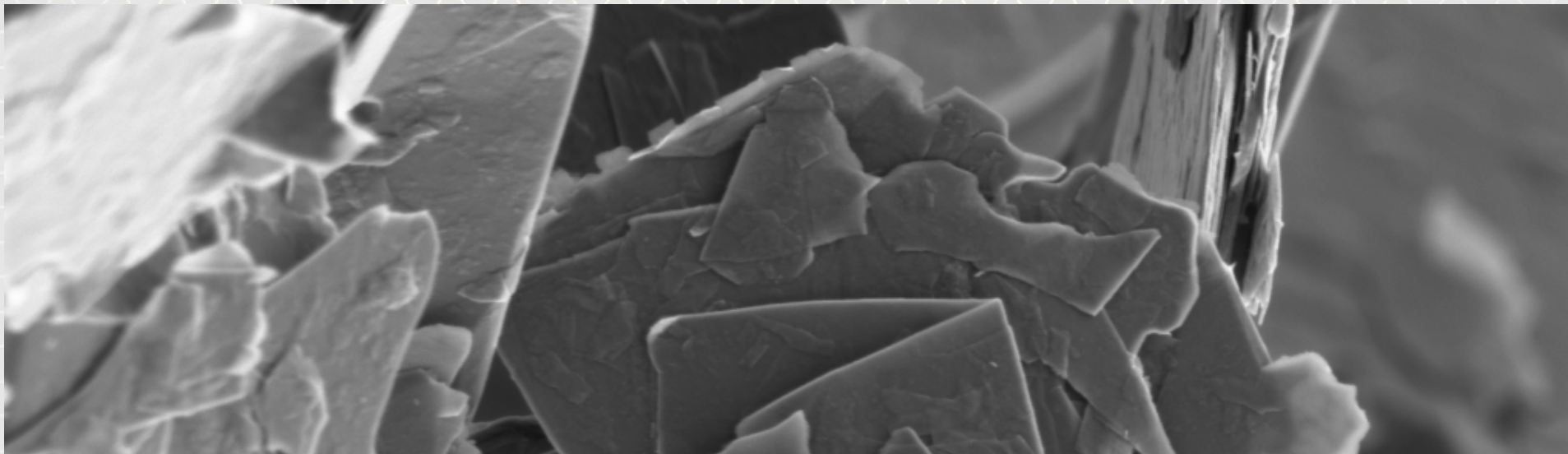
# Graphene reinforced SLS Powders

32% improvement in modulus at 3wt% loading
21% improvement in UTS of the polymer matrix at 0.5wt % loading
17% improvement in elongation to break PEEK matrix at 3wt% loading

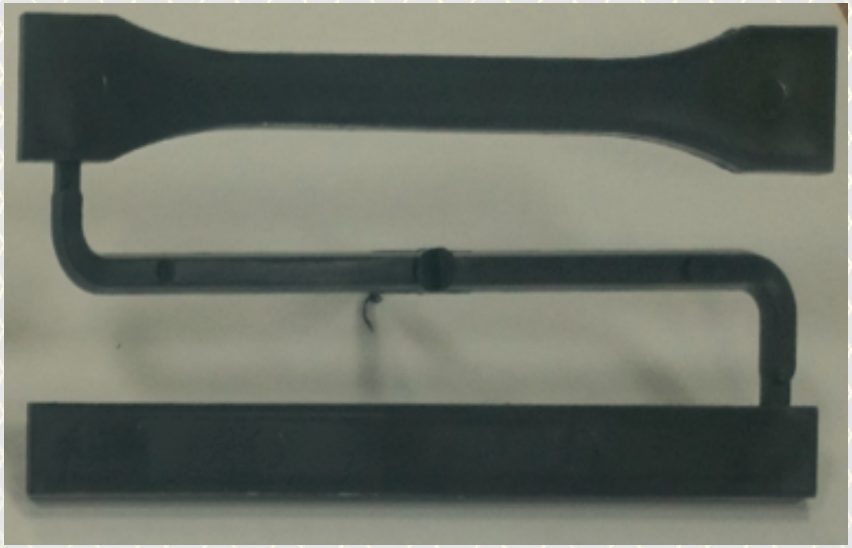


# Additional benefits observed

Graphene incorporated into powders by standard mixing methods
Mechanical properties of films enhanced by low graphene loadings
Efficiency of melting of nanocomposites increased by graphene

# Manufacturing methods achieved

Additive manufacturing
- Fused deposition modelling
- Selective laser sintering
- Injection moulding



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# Feasibility study into Carbon Fibre Composites

**To bridge the gap that currently exists between graphene's potential and its commercial applications**

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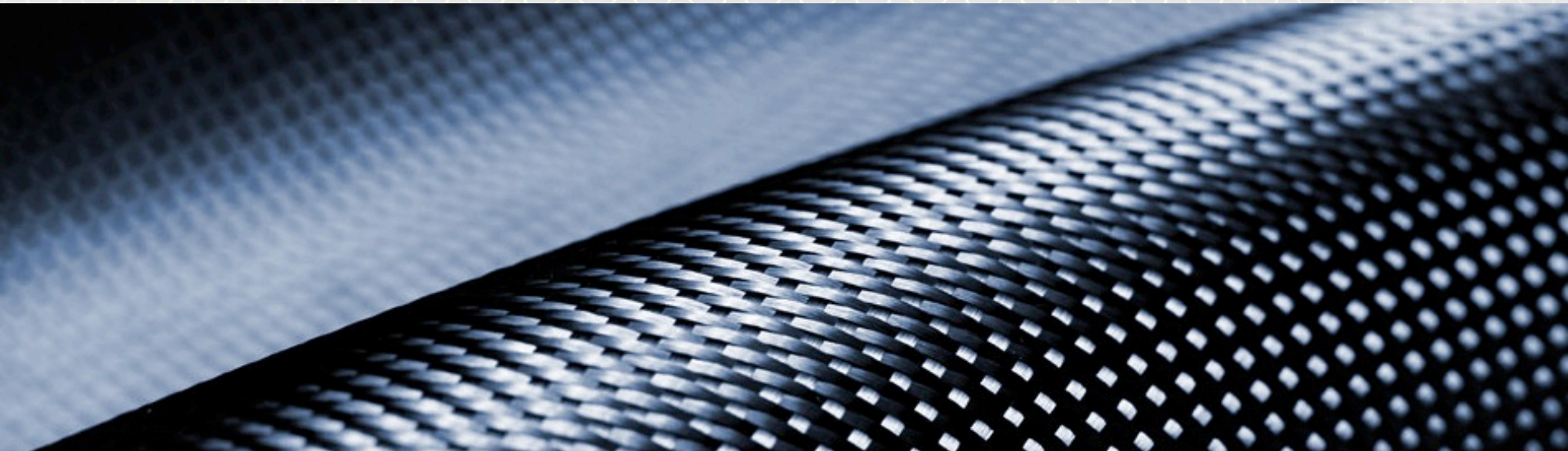
# Graphene reinforced Carbon Fibre Composites

25% improvement in modulus of the Epoxy matrix
30% improvement in longitudinal modulus of CFRP
36% improvement in UTS of the epoxy matrix
23% improvement in transverse UTS of CFRP
52% improvement in transverse sheer strength of CFRP



# Additional properties

Improved performance
Better resin/fibre adhesion
Blunt crack propagation
Enhance thermal dissipation
Induced electrical conductivity

# Real world applications