MANCHESTER 1824

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Intellectual Property **UMIP®**

PRODUCTION OF GRAPHENE AND OTHER 2D MATERIALS

A suite of different methods to produce graphene and other 2D materials

BACKGROUND

Graphene and other 2D materials are expected to have numerous applications and have the potential to be revolutionary in multiple industries. Graphene was first isolated at The University of Manchester (UoM) by mechanical exfoliation of graphite, using an adhesive tape to isolate individual layers of graphene. However, this method is not scalable or suitable for industry.

Graphene and other 2D materials can now be produced by more advanced methods, which include sonication, chemical vapour deposition and chemical exfoliation. These methods produce graphene of differing qualities and not all can produce large enough quantities for most applications. As such, there is a need for a method of producing large quantities of high-quality graphene and 2D materials at a competitive cost.

THE TECHNOLOGY

Academics at the UoM have developed a suite of different methods to produce graphene and other 2D materials, these methods include:

- Electrochemical production of graphene (UMIP Ref: 20110057 and 20160106)
- Solvent free electrochemical production of graphene (UMIP Ref: 20130251)
- Electrochemical production of graphene oxide without strong acid (UMIP Ref: 20130322)
- Production of halographene (UMIP Ref: 10003778)
- Electrochemical production of non-graphene 2D materials (e.g. hBN and TMDCs) (UMIP Ref: 20150231 and 20160139)
- Electrochemical production of water soluble 2D materials (UMIP Ref: 20150411)
- Highly scalable mechanochemical production of graphene nanoplatelets (UMIP Ref: 20160001)
- Simultaneous electrochemical exfoliation and functionalisation of graphene (UMIP Ref: 20160111)
- Wet chemistry process for the preparation of 2D materials with control over the lateral dimensions (UMIP Ref: 20150177)
- Electrochemical production of graphene aerogel (UMIP Ref: 20140062)

Please let us know if you would like further information about these methods

KEY BENEFITS

- The number of diverse, but complementary production methods available at the UoM means that there is likely to be a suitable method for your needs
- Methods enable the production of multiple different 2D materials
- Fast and scalable production methods
- Methods to allow graphene flakes to be tailored to the desired size/morphology
- Production of graphene with the use of cations reduces oxygen content in products
- Solvent free electrochemical exfoliation is more stable and is more safe
- Electrochemical production of graphene oxide, unlike the Hummers Method, does not use potassium permanganate or sulfuric acid and thus is safer with less waste
- Production of 2D materials (e.g. hBN) crystals with large size and tunable thickness
- Mechanochemical exfoliation is eco-friendly and highly scalable

APPLICATIONS

- Graphene and other 2D materials have a vast number of potential applications that range from water purification membranes to composites to supercapacitors
- We believe that this suite of different methods to produce graphene and other 2D materials could help enable the commercialisation of such products

INTELLECTUAL PROPERTY

We have a number of patent families regarding the production of graphene and 2D materials, each at different stages of prosecution (from recently filed to granted).

PUBLICATIONS

- High-yield electro-oxidative preparation of graphene oxide. DOI: 10.1039/C4CC03260H
- Electrochemical exfoliation of graphite in quaternary ammonium-based deep eutectic solvents: a route for the mass production of graphene. DOI: 10.1039/C5NR02840J
- Mechanochemical Exfoliation of 2D Crystals in Deep Eutectic Solvents. DOI: 10.1021/acssuschemeng.6b01195
- Single Stage Simultaneous Electrochemical Exfoliation and Functionalization of Graphene. DOI: 10.1021/acsami.6b12868

OPPORTUNITY

These technologies present excellent licensing and development opportunities for companies with an interest in graphene and 2D material production.

UMIP REFERENCES

20110057, 20160106, 20130251, 20130322, 10003778, 20150231, 20160139, 20150411, 20160001, 20160111, 20150177, 20140062.

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