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GRAPHENE POLYMER NANOCOMPOSITES

Cost effective, high-strength graphene nanocomposites

BACKGROUND

Nanocomposite materials using exfoliated layered fillers have been known for over 60 years with polymer nanocomposites exhibiting substantial property improvements at much lower loadings than conventional micron-sized fillers such as glass and carbon fibres. This offers the possibility of reduced component weight and simplified processing.

It has also been recognised for some time that graphene has impressive mechanical properties and it should come as no surprise that addition of such a filler leads to significant improvement in the corresponding properties of the polymer matrix. Improved elastic modulus, crack resistance and fatigue resistance, for example, are complemented by modifications to other useful properties such as thermal and electrical conductivity and barrier behaviour.

University of Manchester researchers have established a method for polymer nanocomposite production using non-functionalised graphene. For a nanocomposite to have high strength, there must be a good degree of bonding between the base polymer and the graphene to allow transfer of stress into the graphene. Increasing the size of the graphene sheets improves the reinforcement of the nanocomposite as does the use of multi-layer graphene. This technology could lead to the production of cost effective, high-strength graphene nanocomposites.

THE TECHNOLOGY

It has been discovered that 2- to 7-layer graphene can demonstrate similar, or even superior, reinforcement of a nanocomposite compared to single-layer graphene. Two-layer graphene returns approximately the same improvement in elastic modulus as single-layer graphene, while graphene up to 7 layers thick only has a 50% reduction in enhancement. Multi-layer graphene disperses easily into the host material and gives reinforcement to the polymer matrix by transferring or releasing stresses. It can be added in higher densities than single-layer graphene and the results indicate that enhancements to the strength of the material result in a cost saving and very low discolouration of the matrix.

Graphene nanocomposites can be also used to report stress changes in composite systems, which gives potential for use as advanced sensors in several areas.

KEY BENEFITS

- Widespread use of polymers offers multiple opportunities for exploitation
- Low graphene dosage required to yield improved material properties
- Reducing cost of graphene will aid upscaling this technology
- Multilayer graphene is already cheaper to produce than single-layer graphene
- Higher density of multi-layer graphene allows higher dosing, and stronger nanocomposites
- Opportunity to use other 2D materials, such as tungsten disulphide (WS2) and molybdenum disulphide (MoS2) to achieve additional property improvements

APPLICATIONS

- Mechanical load-bearing structures
- Protective coatings
- High performance sports equipment
- Automotive tyres and high-strength brake pads with a high thermal conductivity
- Healthcare – e.g. prophylactics, prosthetics and bone implants
- Strain sensing – in areas such as: aeronautical, automotive and construction panelling, defence, and pipes for water and gas
- Optical filters – altering graphene content to obtain required transparency
- Electronics – production of conductive polymers and transistors
- 3D printing - printing of mechanically strong structures
- Hydrogen storage and fuel cells

INTELLECTUAL PROPERTY

Patent applications have been filed to protect this technology in a number of worldwide territories.

OPPORTUNITY

The technology presents an excellent licensing and development opportunity.

UMIP REFERENCES

10003799, 20110252.

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