From flagship to spaceship—two experiments pushing the frontier of graphene's potential

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Due to its distinctive properties graphene has been held out as a game-changing material for a range of industries and applications. The Graphene Flagship initiative was set up as Europe's biggest ever multi-stakeholder research initiative, to quite literally shape the future of the

technology.

The 10-year Graphene Flagship, partly EU-funded, was set up to exploit the technological potential of graphene and related layered materials for future applications. Research members of the initiative recently conducted two experiments to assess, for the first time, the viability of graphene for space applications. The experiments, in collaboration with the European Space Agency and other partners, tested the material under zero-gravity conditions specifically for light propulsion and also for thermal management applications, with very encouraging results.

Is space graphene's new frontier?

Graphene's unique thermal, light, strength and weight properties make it an ideal candidate to improve the performance of aerospace and satellite applications. In a series of experiments conducted at the end of last year, Graphene Flagship researchers looked specifically at possible use of the material for the improvement of space propulsion, as well as thermal management systems and loop heat pipes.

For the solar sail experiments, a team of graduate students from Delft Technical University, Netherlands took advantage of Germany's 146 metre ZARM Drop Tower microgravity conditions (down to one millionth of the Earth's gravitational force) to investigate the use of graphene for light sails. The team designed free-floating graphene membranes which were then exposed to radiation pressure from lasers, to see how they reacted and indicate how much thrust could be generated. The team repeated the experiment over five trials to overcome initial technical difficulties. Almost 10 seconds of weightlessness was achieved by catapulting a capsule containing the experiment upwards and downwards in a vacuum.

The second experiment explored how heat transfer in loop heat pipes

(cooling systems used extensively in satellites) could be made more efficient, with increased lifetime and autonomy, using graphene. The metallic wicks in the pipe, used to transfer heat into a fluid to cool the system, had their usual porous metal coatings replaced with two types of graphene-related materials. These were then tested for increased thermal conductivity during two parabolic microgravity and hypergravity ESA flights. During each 3-hour flight, the specially modified plane undertook 30 parabolic ascents, achieving around 25 seconds of weightlessness in each parabola.

The results of both experiments demonstrate the versatility of graphene and the researchers involved are now further investigating the influence of radiation pressure on graphene light sails as well as developing commercially available graphene-based heat pipes.

The future lies with innovative people, as well as products

Produced from a carbon layer only one-atom thick, as a two-dimensional hexagonal lattice graphene is both light and strong (said to be about 200 times stronger than steel). Additionally, it has excellent electrical, mechanical, thermal and optical properties, as well as being nearly transparent. These characteristics make it an extremely interesting material for scientists and engineers pursuing the development of a wide range of faster, thinner, stronger and more flexible products.

To explore graphene's potential to revolutionise multiple industries, generating economic growth and new employment, the 10-year Graphene Flagship is designed to represent the entire value chain from materials, to components and systems. A consortium of academic and industry experts from around 150 partners, across 23 countries, coordinate and run its various research strands. The European

Commission contributes directly through funding, along with research results from EU-funded projects such as GRAPHENECORE 1.

Over time, project results will progress efforts towards specific applications for development. Additionally, the research initiative's mission is to provide training and cutting-edge research opportunities for students and young researchers.

More information: graphene-flagship.eu/

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