

Discovery of Graphene

The most exciting material to date of the 21st century

The UK is leading a new wave of scientific breakthroughs that will shape the future of energy

The UK prides itself on its capacity for “outside of the box thinking” across all walks of life. There can be no better example of this tradition than the discovery of the most exciting material so far of the 21st century, graphene, illustrated in a standing exhibition in the UK Pavilion. Two academics at Manchester University regularly held what came to be known as “Friday night experiment” sessions, where they would try out experimental science not necessarily linked to their day jobs.

During one such Friday night, the two scientists removed some flakes from a lump of bulk graphite using sticky tape. Some flakes, they noticed, were thinner than others. So they set out about separating the graphite

fragments repeatedly until they managed to create flakes which were just one atom thick. They had isolated graphene for the first time.

Initially their claims were rejected, as few believed that sheets just one-atom in thickness could be stable. In 2004 they finally were accepted by a publisher, Science, who would credit their findings. The world of science was immediately abuzz at this extraordinary, almost incredible, discovery. Six years later, in 2010 Andre Geim and Kostya Novoselov were awarded the Nobel Prize in Physics.

From its unlikely Friday night start the isolation of the world’s first two-dimensional material has captured the imagination of scientists, researchers and industry across



Example of a graphene display screen

the globe. Today, in the home of graphene, the UK is leading a new wave of scientific breakthroughs that will shape the future of energy and create new possibilities for the way future generations live their lives. Graphene is unlike any material that has gone before. Ultra-light, it is also immensely tough - 200 times stronger than steel yet immensely flexible. At just one atom thick, graphene is self-evidently the thinnest material possible, as well as being transparent. Yet it is a superb conductor and can act as a perfect barrier - not even helium can pass through it.

We are just at the very outset of discovering the possibilities for graphene.

“Graphene is a unique crystal in a sense that it has singlehandedly usurped quite a number of superior properties: from mechanical to electronic. This suggests that its full power will only be realised in novel applications which are designed specifically with this material in mind, rather than when it comes to substitute other materials in existing applications.”

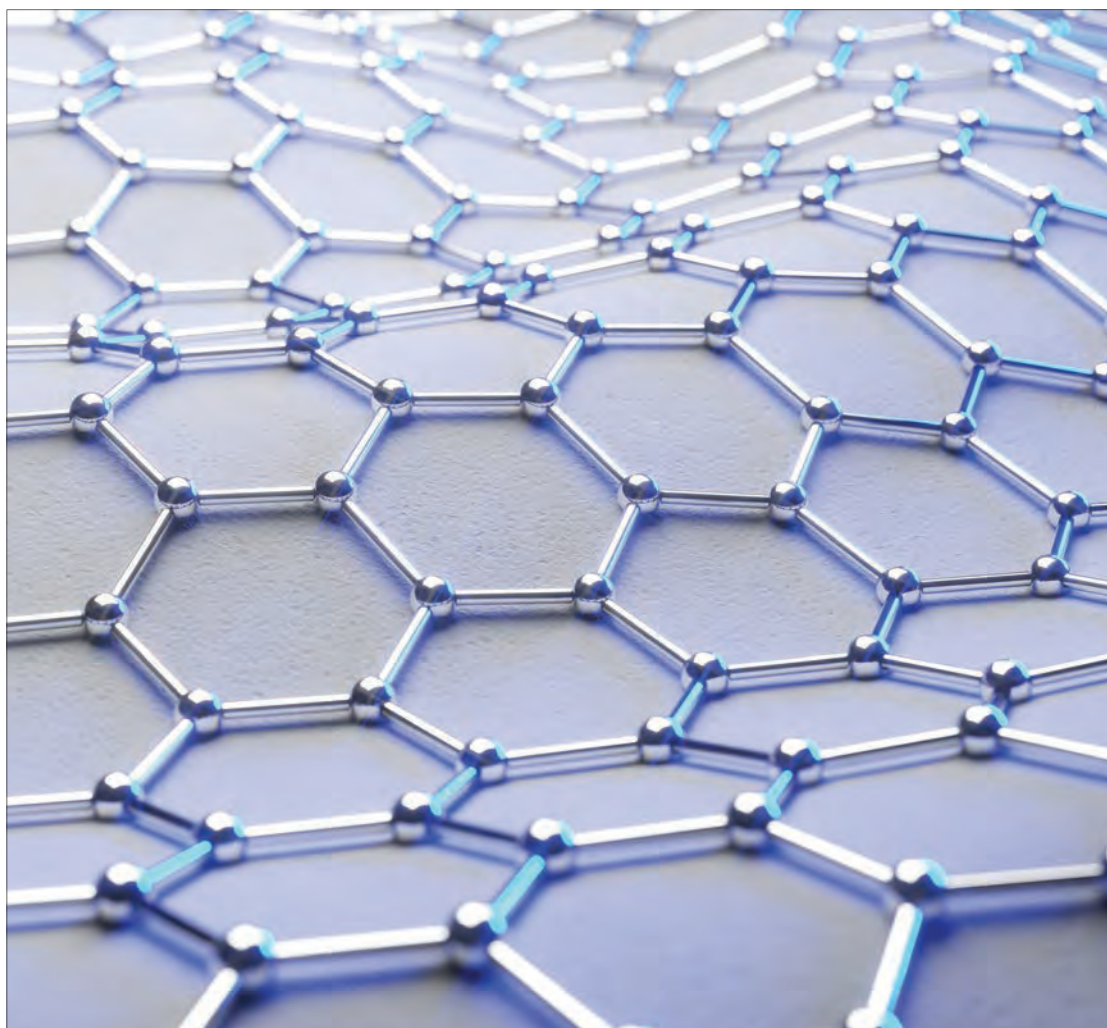
Professor Sir Kostya Novoselov

At the National Institute of Graphene in the University of Manchester energy is one of the main applications under research, alongside membranes, composites and coatings, biomedical applications, sensors and electronics.

Via Graphene, the UK is leading a new wave of scientific breakthroughs that will shape the future of energy and create new possibilities for the way future generations live their lives.

Besides graphene, a number of other pop-up displays will be featured in this final gallery during the three-month duration of the EXPO 2017. The UK's business programme will focus on strengthening UK-Kazakhstan relations in the oil, gas and mining sectors as well as infrastructure and technology. The UK is the first country to propose an end date to using unabated coal and believes that a range of energy sources such as nuclear, offshore wind and shale gas all have roles to play in the low-carbon energy mix. The UK is one of the best places in the world to invest in renewable energy as well as being widely regarded as technology leaders and innovators in the fields of oil and gas.

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3d illustration of graphene molecular grid. Atoms connected in the hexagonal crystal lattice.

Photographing the fleeting moments of physical change

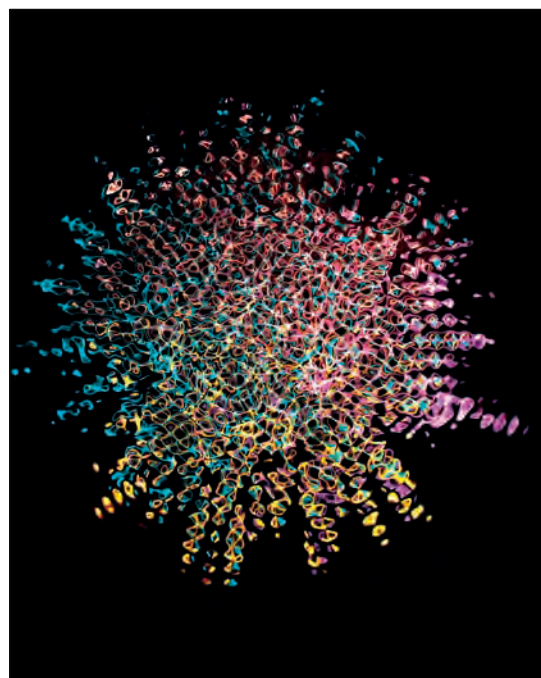
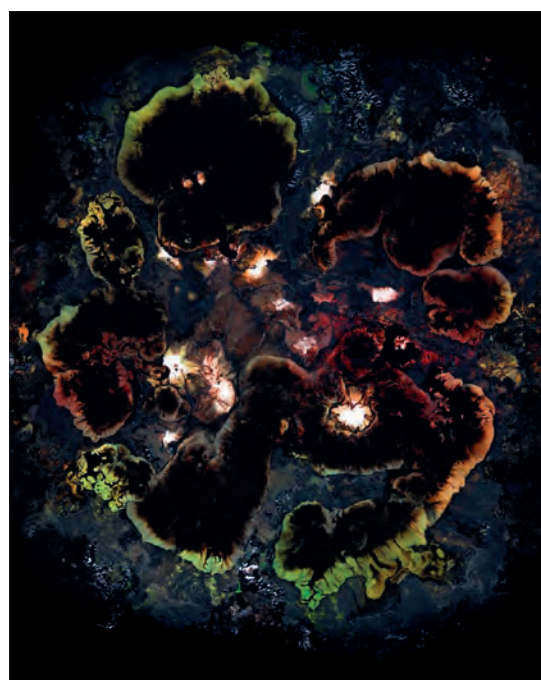
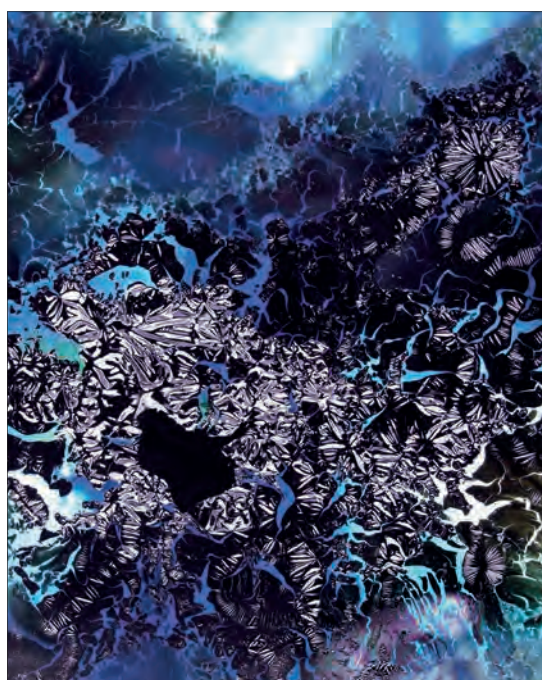
The beauty of graphene

There is beauty to be found in the material of graphene itself, as Andrew Hall explores with his mesmerising series of photographs on display in the upper-floor conference space at the UK Pavilion.

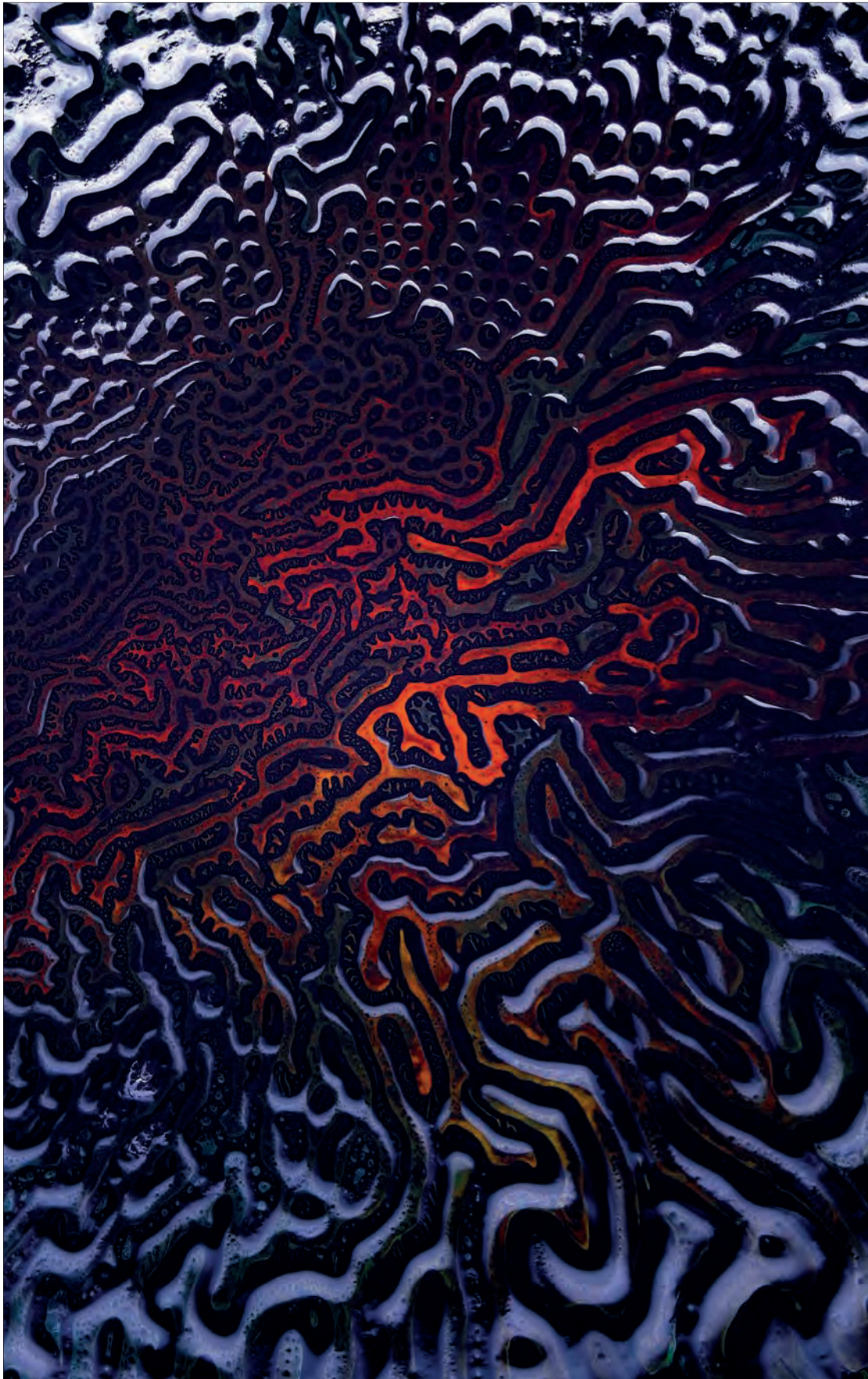
“Chasing and photographing the fleeting moments of physical change that these natural phenomena display are endlessly fascinating and beautiful to me. The series of photographs I have created for the British Pavilion at the Future Energy Expo in Astana are inspired not only by the

properties and applications of Graphene, but the spirit of its discovery and the natural forces it represents. The images form part of an ongoing exploration of the relationships, harmonies and rhythms present in nature, where the same physical laws force the growth of a tiny seashell to follow a similar pattern as a river delta seen from space. All of the photographs created for this project represent a specific moment in time. They remain a unique record of precisely timed combinations of liquid, colour and texture brought together to interact and reveal the beauty of that moment.”

Andrew Hall



Top row: 'Surface Tension' and 'Transient'
Bottom row: 'Half Life' and 'Cumulative'



The spirit
of discovery