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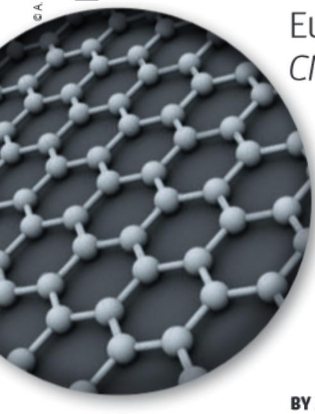

01 The ideal crystalline structure of graphene is a hexagonal lattice.

Nanotechnology Since its discovery in 2004, graphene has generated tremendous interest for its exceptional electrical and mechanical properties. This year, the European Commission has selected it as a Future Emerging Technology (FET) Flagship. *CNRS International Magazine* explores ongoing research in this promising new field.

In for the Graphene

BY XAVIER MÜLLER

Graphene consists of a single sheet of carbon atoms arranged in a hexagonal "honeycomb" lattice similar to graphite (formed by multiple layers of graphene). An excellent electrical and thermal conductor, both flexible and mechanically resistant, graphene can be "doped" to become a semiconductor like silicon in electronic circuits. Andre Geim and Konstantin Novoselov, who first isolated it in 2004, were awarded the 2010 Nobel Prize in Physics in recognition of the potential of this extraordinary material. In January this year, the European Commission made this new field of research one of its first Future Emerging Technology Flagship projects, funded to the tune of one billion euros over the next 10 years (*see box*).

Although practical applications are a long way away, many researchers have already joined the race to develop graphene-related technologies. Along with Asia and the US, France has been at the forefront of this effort ever since 2005, through its National Research Network on Mesoscopic Physics and the creation of the Graphene and Nanotubes (GNT) International Research Network (GDRI), involving 60 research teams in France and Europe. Both structures are driven by CNRS.

France is now a leader in graphene research, not only regarding synthesis but also characterization and applications in electronics. Synthesis is all the more important as the method used by the two Nobel laureates cannot produce samples in large quantities. For practical purposes, they used adhesive tape to strip off layers of graphite until only a single sheet of graphene remained. "Fortunately, this material can be produced using other methods, which French research is also investigating," explains Annick Loiseau, a researcher at the LEM[1] in Paris, and director of the GNT Research Network. Epitaxial growth on silicon carbide, for example, is a very interesting approach consisting in heating this artificial mineral used as an industrial abrasive. The silicon atoms on the surface evaporate, leaving behind a sheet of graphene. "Chemical vapor decomposition"—or CVD—is another promising method where a carbonated gas like methane is decomposed at the surface of a metal such as copper or nickel. The carbon released reorganizes itself in graphene sheets. Finally, it is also possible to exfoliate graphite using chemical techniques. France has many facilities for experimentation and characterization, including the synchrotron Soleil or the LNCMI[2] in Grenoble. French laboratories are putting

The EU Invests in Graphene

BY BRETT KRAABEL

→ The European Commission (EC) has selected graphene as one of the first Future Emerging Technology (FET) flagship projects. With a budget of €1 billion, the 10-year project aims to boost the EU economy by federating the efforts of researchers, entrepreneurs, and industrialists across Europe to transform graphene from a laboratory phenomenon into a wellspring of revolutionary applications.

Judging by the number of scientific publications on the subject, the EU is already world leader in graphene research. Yet "Asia produces about 10 times more patents on graphene," explains Annick Loiseau,[1] project coordinator for France and CNRS representative within the program. To ensure that Europe gets a strong return on investment, the flagship project is designed to foster collaboration between research and industry.

The scheme involves 74 academic and industrial partners from 17 EU countries. Academic research institutions such as CNRS make up nearly half of the partners involved. France is the largest contributor to the graphene FET, with 14% of the initial budget spread across 15 laboratories, 11 of which from CNRS. These laboratories cover disciplines such as materials science, electronics, nanotechnology, biology, magnetism, or ecology, to name but a few. By harnessing the synergies created through these collaborations, the flagship project should generate many exciting new applications for graphene, such as high-speed high-power electronics, flexible displays, and new composite materials for the aerospace and medical fields. These and other applications are expected to have a significant knock-on effect on industry, the economy, and society as a whole.

01. Laboratoire d'étude des microstructures (LEM) (CNRS / Onera).

CONTACT INFORMATION:
LEM, Châtillon.
Annick Loiseau
› annick.loiseau@onera.fr