Graphene Offers Rubber Industry New Prospects

The adoption of graphene applications would be a boon not only for E&E sectors but also for manufacturing, healthcare and rubber industries

By **Philip Chan**

Rubber is one of the most important materials in the world offering a wide range of applications from heavy engineering down to small and intricate electronic products. The contraction of consumer products has made a great impact on manufacturers to push their limits in R&D as well as in advance failure and material analysis.

With Malaysia renowned as among the world's top three rubber producers, the adoption of graphene applications would be a boon for the Malaysian rubber industry, especially its downstream manufacturing sector.

The discovery of graphene began in 2003, when scientists at the University of Manchester found that they could peel off a gossamer film of the material just by touching a piece of ordinary sticky tape to a block of purified graphite the solid form of carbon that's mixed with clay and used as the "lead" in most pencils.

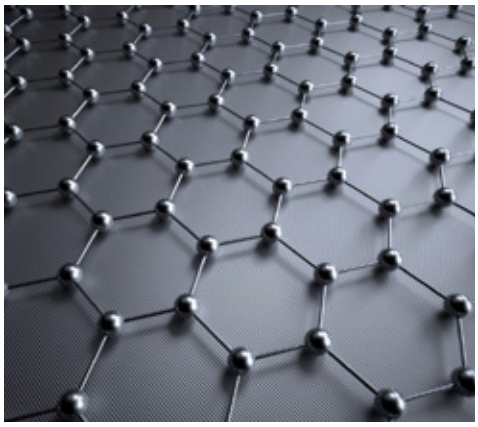
It earned its discoverers, Professor Sir Andre Geim and Professor Sir Kostya Novoselov of the University of Manchester, the Nobel Prize in 2010, for their ground-breaking experiment of 2D material.

Since then, the funding of the graphene research has reached almost €1 billion. However, researchers have spent years struggling to manufacture it on larger scales and figuring out how its remarkable properties could best be used.

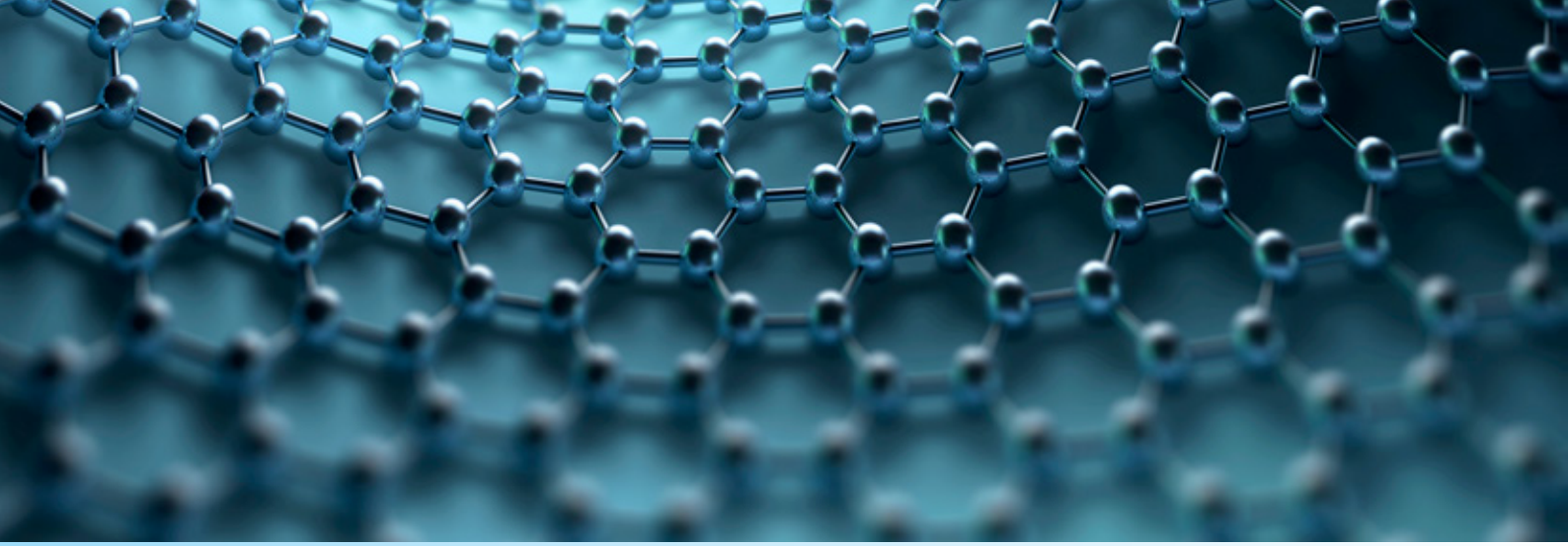
Graphene is a one-atom-thick layer of carbon atoms arranged in a hexagonal lattice. It is commonly known as the "wonder material" due to its superior properties.

Being the thinnest compound known to man, it is harder than diamonds, 200 times stronger than the strongest steel. It is also renowned as one of the best heat and electrical conductors at room temperature, impermeable to gases while being transparent, highly flexible and even stretchable.

At a recent MIMOS Talk Series, the topic on potential applications of graphene towards boosting the rubber industry's downstream sector was shared by two well-versed researchers, Prof. Ir. Dr. Cheong Kuan Yew from Universiti Sains Malaysia and Dr. Lee Hing Wah, Senior Staff Researcher of MIMOS.



MIMOS webinar entitled *Transforming Rubber Industry through Advanced Analysis Techniques & Graphene Application* was specially designed for rubber industries professionals, academicians, and researchers towards providing detailed techniques to resolve issues related to rubber materials.



R&D EFFORTS ON GRAPHENE AT MIMOS

MIMOS has been facilitating the growth of Electrical and Electronics (E&E) sector, focusing on supporting the integrated circuit design ecosystem; providing expert services in advanced materials; and offering end-to-end shared services facilities for industry, academia, small and medium entreprises (SMEs).

In terms of advanced materials, MIMOS offers excellence in research and development (R&D) in the area through its shared facilities which include graphene for wide-ranging applications. Graphene can be used in printed technology, wearables technology, flexible electronics applications, and even in other fields, thus giving opportunities for SMEs to venture into new market segments.

During the talk, Dr. Lee shared his insights on the characteristics and the use graphene for E&E and various sectors, including rubber industry.

Renowned as the "wonder material", graphene can be commercially manufactured in two ways by either the chemical vapour deposition (CVD) or liquid phase exfoliation (LPE) methods.

The methods used will be determined by its application in the different types of industries. For instance, the CVD process produces a high-quality graphene which is pristine and applicable for the E&E industries.

Dr. Lee said another interesting property of graphene that MIMOS is keen to explore is its electrical properties which are 100 times more conductive than silicone due to its high electron mobility. He added that graphene is very light, transparent, one million times thinner than a human hair and has the fastest thermal conduction in the world.

In terms of graphene research, Dr. Lee added that his team has developed pristine monolayer graphene on substrates which could be up to 8-inche silicon wafer or catalyst wafer. This CVD process is more suitable for electronics-based research applications to meet their high-quality requirements.

"At the same time, MIMOS has also developed its own functionalised liquid-based graphene materials because most of our collaborators are in the E&E sector to support their work.

"In our pursuit to capitalise on the amazing properties of graphene, we have also developed different types of graphene using nano-material, silver, copper or any other metals, and conductive ink that can be used for ink-jet printing to serve different types applications and market.

"We have developed different types of transparent graphene for functionalised material such as metal or polymer. By using the ink-jet technology, we are able to develop sensors, anti-static coating and anti-microbe coatings," Dr. Lee explained.

In addition, its elastic strength and flexibility are ideal for applications in the rubber industry.

For the rubber industry, the application of graphene can be used in a wide range of consumer-based industries from tyres, condoms, sports and fitness footwear to medical, healthcare, wellness, anti-bacterial gloves and reusable face masks. The wonder material could be used for rubber or latex to enhance its toughness and flexibility, which makes it a value-added component for rubber-based products.

To further advance graphene-enabled future applications, Dr. Lee added that MIMOS would be targeting on the Internet of Things (IoTs) and consumer-based segments for sensor devices, healthcare, wearables, and a slew of everyday applications.

POWER OF ENGINEERING SCIENCE

Meanwhile, Prof. Cheong, a passionate researcher, educator, trainer, consultant, and professional engineer of material science and engineering for more than 20 years, elaborated on the importance of scientific research and evidence-based initiatives.

Prof. Ir. Dr. Cheong Kuan Yew
FIEM, SMIEEE, USM

In his presentation entitled *Bridging Industrial Issues & Applications with Engineering Knowledge*, Prof. Cheong outlined the importance of R&D, science philosophy; engineering design and characterisation; identifying the problems, failure analysis, eco-system of characterisation, solutions and hierarchy of characterisation tool to achieve success.

He said that every step of problem-solving should be based on evidences and fundamental science with the attitude of arriving at the optimal solution.

To achieve success in resolving industrial issues and applications, it is pertinent to employ hard-core engineering science philosophy of technical knowledge, intuition, logical thinking and professionalism (ethics) with eight core factors related to engineering materials namely structure, process, performance, property, scale, sustainability, economic, and characterisation.

Combination of these eight factors are fundamental to help find the root cause to a problem during the failure analysis.

Prof. Cheong said it is crucial for one to remain focused and be accountable to resolve the problem. It is important to understand material characteristics such as its properties after one has imposed on the external process, mechanical and chemical properties; by-product and dimensions, to name a few.

IMPORTANCE OF FAILURE ANALYSIS

Failure analysis will be based on the characterisation of materials and the selection of the right platform. The first step includes obtaining the data application technique with the objective to use a particular method to solve a problem, while consultation input and selection of appropriate tools play critical roles.

Interpretation of data and selection of correct techniques and tools are also vital for the analysis. Data evidence will lead to the solution, as a famous quote by Thomas Fuller goes "Seeing is believing, but finding it is the truth".

The next step is the hypothesis which will eventually help to resolve the problem. The root cause will be proposed to pinpoint the direction of the solution.

The most appropriate solution would be to undertake a generalisation approach in the selection of tools from an engineering perspective. In addition to characterisation, teamwork is equally pertinent together with the interpretation of data to attain the right or optimal solution.

Prof. Cheong also spoke on the comparison on the rubber and latex materials that will give a whole idea on the morphology as well as surface analysis.

Concluding his talk, he said that adopting a one-stop centre approach such as using MIMOS' shared services where characterisation, data interpretation and consultation input can be obtained under one roof, would appropriately provide necessary assistance for industry players.

For collaborations and opportunities in the graphene applications, contact MIMOS Berhad at +**603 – 8995 5000** or email to **info@mimos.my.**