

GRAPHENE SET TO REVOLUTIONISE WEARABLES TECH

The future of the global manufacturing industry will be defined by five key trends by 2025 including transition towards demand-driven supply chain; embracing digital solutions and automation; greater flexibility of supply chains; and, repurposing manufacturing capabilities.

 By **Philip Chan**

In addition, changing economic conditions and consumer preferences will impact the manufacturing sector, which it will have to adapt to the 'new normal'. The supply chain transformation is set to become more localised and flexible with consideration of new ways to utilise external manufacturing capabilities.

trend for the manufacturing sector also include the applications of new materials that will further provide the growth impetus in contributing to the nation's industrialisation progress and economic wealth.

MIMOS Head of Flexible Electronics R&D Lab, Dr Lee Hing Wah, said graphene offers a huge potential and enabling technology for future applications in multi-faceted billion ringgit industries from wearables, healthcare, automotive, consumer-based products to advanced materials, IoT, devices and sensors.

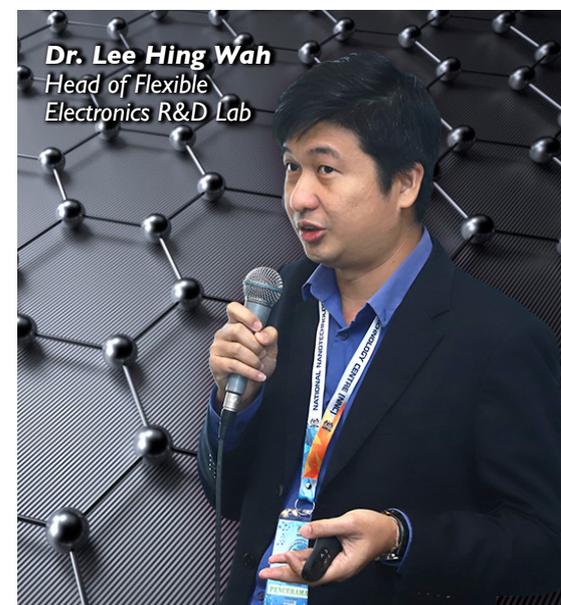
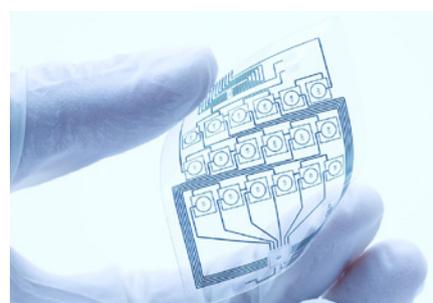
One of the new materials that is being currently explored globally for its amazing properties is the wonder material known as graphene. This wonder material offers wide ranging applications from industrial engineering, intricate electrical and electronic products to consumer-based products, wearables and Internet of Things (IoT).

He said the early adoptions of graphene-based derivatives might be the better option as its usage provides a more flexible and suitable process to attain manufacturing and business sustainability.

According to global market research company Euromonitor International, around 30 per cent of manufacturing companies plan to increase production localisation efforts over the next six months to better shield from future risks. In addition, the study stated that about 50 per cent of companies plan to reshape their digital strategies and invest into e-commerce, while one-third of respondents will accelerate investments into automation tools.

To encourage Malaysian manufacturers and SMEs to tap new available business opportunities, MIMOS initiated a recent talk on the subject following its successful R&D initiatives entitled "Graphene: The Wonder Material Revolutionising Wearable Tech".

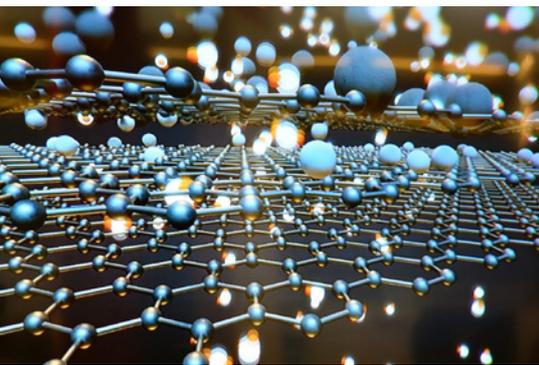
With the rapid digitalisation and emerging technologies as espoused by advocates of Industry 4.0, the future





AMAZING PROPERTIES

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.



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

Dr. Lee explained that it can be used in printed technology, wearables technology, flexible electronics applications, and even in other fields, thus giving abundant opportunities for SMEs to venture into new market segments.

It 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,” he added.

WEARABLE TECHNOLOGY APPLICATIONS

Wearable technology, also known as “wearables”, can be defined as a category of electronic devices that can be worn as accessories, embedded in clothing, implanted in the user’s body, or even tattooed on the skin. The devices are hands-free gadgets with practical uses, powered by microprocessors and enhanced with the ability to send and receive data via the Internet.

Meanwhile, the International Electrotechnical Commission (IEC) TC 124 Standardisation covers the field of wearable electronic devices and technologies which include patchable materials and devices, implantable materials and devices, ingestible materials and devices, and electronic textile materials and devices.

According to the Frost & Sullivan 2019 report on “Top 50 Emerging Technologies & Growth Opportunities”, it has been noted that printed sensors will disrupt the healthcare, consumer electronics and automotive industries. It stated that cumulative market size (2017-2019) for wearables and automation in driverless vehicles contributed to US\$ 70 billion market growth.

In addition, the European Union Graphene Flagship has provided a €1 billion budget to explore graphene interest for targeted sector from 2012 to 2022.



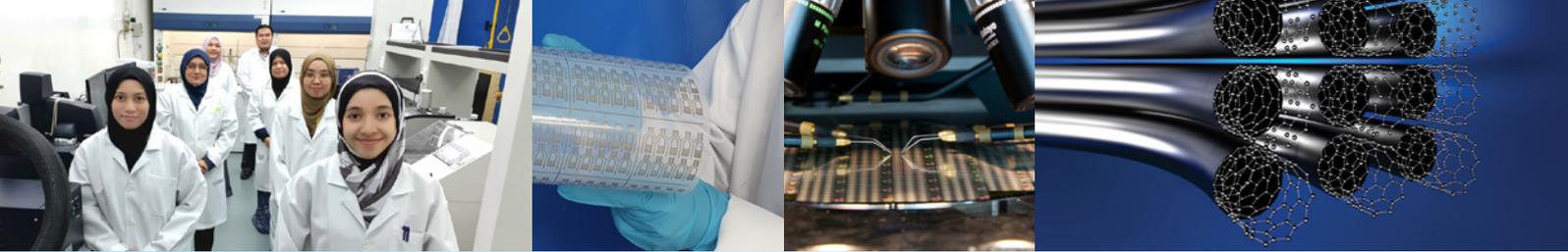
Dr. Lee said that graphene applications could also be incorporated into other segments of industries such as housing development, machinery, automotive and other types of devices such as robotics and rubber-related products.

“We strongly believe that the opportunities for graphene applications will surge tremendously in the next two decades, thus providing SMEs tremendous prospects to grow their businesses. It is our hope that local manufacturing companies and SMEs will seize the opportunities by exploring collaboration with MIMOS on graphene applications to further advance their businesses,” he added.

On the vision for the future, Dr. Lee said it is aimed at looking into the connectivity, devices and a host of other applications that could be seamless onto the human body, machinery and buildings, among many others.



“With the improving lifestyles of people, the expected properties of wearables should be stretchable and transformable, thin and seamless, transparent, flexible surface, flexible conductor and electronics, and flexible energy supply.”



MIMOS WEARABLES RESEARCH

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

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. Being extremely light, transparent, one million times thinner than a human hair, graphene has the fastest thermal conduction in the world.

At the same time, MIMOS has also developed its own functionalised liquid-based graphene materials because most of its 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 of applications and market.

“We have developed different types of transparent graphene for functionalised material such as metal or polymer. These graphene inks could be used for printed and flexible PCB, flexible and wearable electronics platforms, flexible and wearable RFID, sensors, devices and others, including anti-static and anti-microbial coatings,” said Dr. Lee.

Dr. Lee added that his team is also working on the R&D to develop a standardised, “one-fit-all solution” graphene ink that could be applied to any types of substrates or materials for different applications.

The elastic strength and flexibility of graphene are ideal for wide ranging applications for industries, including consumer-based sectors from tyres, condoms, sports and fitness footwear to medical, healthcare, wellness, antibacterial gloves, reusable face masks and automotive wearables.

FUTURE ENHANCEMENTS

To further advance graphene-enabled future applications, Dr. Lee opined that MIMOS would be targeting on the IoT and consumer-based segments for sensors, devices, healthcare, buildings, and a slew of daily electronic applications.

MIMOS’ has tested and proven that graphene can also be incorporated into an extra-stretchy glove where the wearer can seamlessly give commands to execute orders to move a robotic arm in various directions.

Other areas of interest include the incorporation of graphene into “smart” rubber shoes because of its elasticity and lightness that could enable athletes to monitor their performance through a seamless manner; rust-free, weather-proofing/packaging; sports equipment, paint and other consumer products.

As for the healthcare segment, research would be undertaken to develop a seamless transparent graphene battery-free wearable patch that can monitor one’s health condition.

Dr. Lee said that automotive wearables are also another sub-sector that would be explored as cars incorporate a lot of sensors such as seamless and flexible displays, built-in sensors that are printed and wearables, and multi-function overhead control panel.

“Moving forward, we are excited to explore new developments of IoT and Internet of Nano Things (IoNT) under 4IR, where these smart platforms are mainly sensor-fed which fits ideally to be graphene induced.

“For companies that are willing to invest in enhancing their operations through digitalisation, automation and technology know-how, the business opportunities will continue to remain extremely bright over the next 10-20 years.

“Hence, we hope local companies and enterprises will take advantage of MIMOS R&D initiatives towards supporting the national development agenda in becoming a technology producer,” added Dr. Lee.

As Malaysia’s national applied R&D centre, MIMOS plays a strategic role as policy advisory for 4IR in supporting the national development agenda in driving 4IR towards facilitating the nation’s aspirations in becoming a technology producer.

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

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