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MBOT
LEMBAGA TEKNOLOGIS MALAYSIA
MALAYSIA BOARD OF TECHNOLOGISTS

TECHIES

Advanced Materials of the Future

Graphene-based Supercapacitors
– a Breakthrough in Energy Storage Limit

Future of Thermal Materials:
Inspiration from Nature

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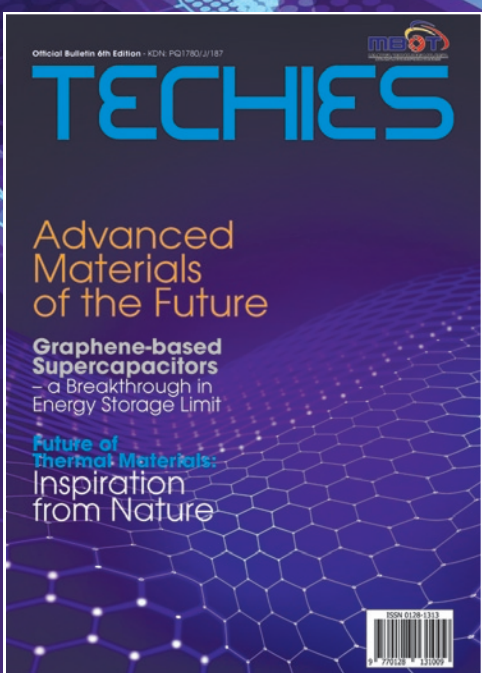

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Editorial Adviser
Datin Paduka Ts. Dr. Siti Hamisah Tapsir
(Head of Publication Committee & MBOT Board Member)

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Emi Fariza
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M.T. Soo
K.Y. Tay

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MBOT would like to thank all those who have contributed in one way or another towards the successful publication of this bulletin.

Editor's Note
Advanced Materials Technology

Dear Readers,

Advanced materials drive the future of the world's economy. In line with this, we present a host of related articles, including a study on the limitation of energy storage, new challenges in aviation, cancer diagnosis and nano-biosensor, and the discovery of polymeric paints. The reader will be made to see that disruptive innovation has now spread its wings to include the manufacturing, retailing, transportation and construction sectors. With technology change, advanced materials engineering also transform tremendously. Smart materials and composites, as well as strong and efficient substances, should no longer be economically feasible only, but sustainable and environmentally-friendly as well. Indeed, we should always safeguard our natural ecosystem. Propelling improvement and thrusting innovation must not be carried out at the expense of our health and well-being.

That said, let me now take the opportunity to thank everyone who has contributed to Techies in various capacities. I would also like to urge our readers to submit research findings/input to be published in our future issues. As we constantly strive to improve the content of the bulletin, we appreciate your feedback. We will use your input to further enhance the quality of the publication so that it remains useful and relevant at all times.

Happy Reading!

President's Note

Tan Sri Dato' Academician (Dr)
Ts. Hj. Ahmad Zaidee bin Laidin FASc

First of all, I would like to congratulate Tun Dr. Mahathir Mohamad on being sworn as Malaysia's 7th Prime Minister, and the Pakatan Harapan (PH) alliance for winning Malaysia's 14th General Election. This is a historic step for our country. It is fortunate for us that we can rely on your leadership for this 'new' Malaysia.

I am confident that the trust placed in you by Malaysians will inspire you to continue important efforts in promoting the unity of our country.

In conjunction with the 'new' Malaysia mode, our website is transitioning to a refreshing new look to provide the best and efficient service for our stakeholders. We felt our site should reflect our personality as a Professional Body for Technologists and Technicians.

Our services have not changed, but the way we display them has. I hope you find the navigation more intuitive and the overall experience more enjoyable and helpful with our newly redesigned site.

In addition to this enhancement, MBOT's online assessment will kick start in the month of July 2018. The pilot assessment will be open to four (4) technology fields namely Automotive Technology, Cyber Security Technology, Aerospace & Aviation Technology and Oil & Gas Technology.

The MBOT assessment is unique and will be based on the respective technology fields. The assessment is crafted by the Technology Expert Panel (TEP) and will be driven by the industry. This industry driven type of assessment is important to ensure that MBOT's Professional Technologists and Certified Technicians have the highest credentials that will meet the expectations of the industry.

The Professional Assessment modules formulated by the TEP aims to cover the latest technology on the ground and shall be updated as and when needed to maintain its relevancy. Each technology and technical fields shall have a specific assessment based on its own niche and will involve professional review (if required) in terms of skills as well as specific knowledge which is needed to become a certified and recognized professional.

I hope with the support and cooperation of TEP members and industry players will be able to increase acceptance and recognition of Professional Technologists and Certified Technicians among industry players.

About MBOT

LEMBAGA TEKNOLOGIS MALAYSIA
MALAYSIA BOARD OF TECHNOLOGISTS

- The Parliament of Malaysia has enacted the Technologists and Technicians Act 2015 (Act 768), an act to provide for the establishment of Malaysia Board Technologists (MBOT), in line with other professional bodies in Malaysia.
- MBOT is responsible for the registration of graduate technologists and qualified technicians as well as to recognise professional technologists and certified technicians.
- MBOT promotes education and professional training in related technology and technical fields.
- MBOT recognises technological careers and empowering technical and vocational education and training (TVET).
- MBOT will strive to be signatory to international accords in the field of technology and technical to ensure the technologists and technicians produced in the country meet international standards and ability to compete globally.

VISION

To be a world class professional body for technologists and technicians.

MISSION

To elevate the standing, visibility and recognition of technologists and technicians.

OBJECTIVE

To increase the pool of skilled workforce required to attain a high income economy, and to protect public safety and health.

WHO SHOULD REGISTER?

✓ **Professional Technologists**
Graduate Technologists with practical experience as stipulated by the Board

✓ **Graduate Technologists**
Holds a bachelor's degree recognised by the Board

✓ **Certified Technician**
Qualified Technician with practical experience as stipulated by the Board

✓ **Qualified Technician**
Holds a certified qualification recognised by the Board

Advanced Materials of the Future

Prof. Dato Dr. Mohd Mansor Salleh

The theme for this Sixth Edition of MBOT Bulletin TECHIES is Advanced Materials.

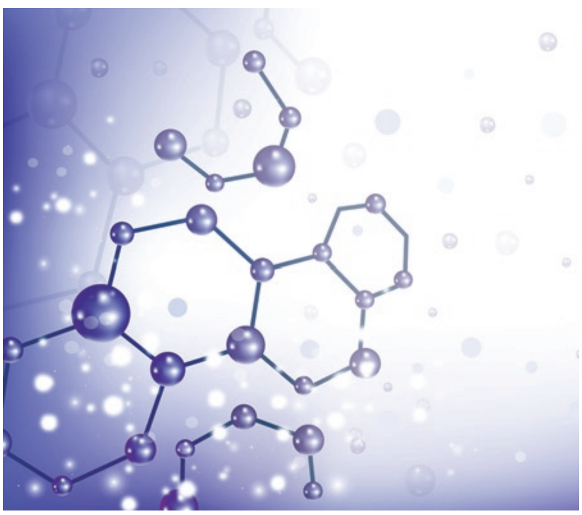
When we talk of materials we are dealing within a vast field of interdisciplinary studies working on hundreds and thousands of different materials which traditionally includes metals, polymers, ceramics and composites. This very wide scope of studies is reflected in the width of the coverage of the articles written for this issue of TECHIES. The topics covered range from thermal materials through composite materials to graphene, which can be said to be among the most promising material of the future. There is also a short description of a Scanning Probe Microscope (SPM) showing one of the newer techniques available to study the interaction of various forces, be it magnetic, adhesive or friction forces on a microscopic surface.

It is the availability of the new advanced analytical techniques that have contributed to our more comprehensive understanding of materials properties. As we may be aware, Materials Science deals with the relationship between the atomic, microstructure and macrostructure with the final properties of the materials. That knowledge is useful for us to produce and manufacture materials with properties required for very specific l applications.

The fifth article in this issue of TECHIES describes ongoing research work between Universiti Teknologi MARA researchers working with professionals in the Institute of Materials Malaysia and PETRONAS. They aim to provide a "Mill Certificate" (Coating Fingerprint Certificate) for polymeric paints for anti-corrosion application. This is a very novel idea, producing a Certificate along similar lines as the Mill Certificate of metal parts showing metal composition from manufacturers for quality control purposes.

Mankind has been using materials since time immemorial. Even the historical times was named after the predominant material in use at the time. For example, we have heard of the Stone Age, the Bronze Age and the Iron Age. It is not impossible that in the near future, we may be coming to the Graphene Age.

It is difficult, or almost impossible, to surmise what is coming our way in the next two or three decades in terms of new materials. Researches being done on newer materials will take time for them to come to fruition and become



> *"Mankind has been using materials since time immemorial. Even the historical times was named after the predominant material in use at the time. For example, we have heard of the Stone Age, the Bronze Age and the Iron Age. It is not impossible that in the near future, we may be coming to the Graphene Age."*

commercially useful and available economically. Requirements of societies are so diverse that it is difficult to pinpoint future directions of materials development with accuracy.

As everything we use is made of materials, the advancement of new technologies and future engineering challenges to help mankind solve problems facing society, will depend on the availability of materials with the required properties and performance characteristics. For example, the problem of energy shortages, the presence and easy access to clean water, and housing infrastructure, will all fall back on having the right advanced materials to solve them. Hence further research and developments of suitable, cheap and readily available materials is imperative.

Presently, one of the much talked about new advanced material is graphene. It is a product of research and developments in nanotechnology and nanomaterials. Its possibilities for diverse applications are tremendous. It is the thinnest known material as well as the strongest and most flexible. Gases and liquids cannot permeate through even a single layer of graphene, thus making it highly inert and chemically stable.

Among the possibilities of this materials' use are for communication and information technology, medicine and cosmetics, environmental and climate changes, batteries, transportation and future energy. It covers almost all the problems presently facing mankind.

The way to go is to refine and perfect the production of graphene and conduct more interdisciplinary research cutting across engineering, medicine, electronics and energy areas of human endeavor. Nanotechnological advances will propel more products through the use of new sophisticated manufacturing and production techniques.

There are other areas of materials research and developments worthy of mention. This includes work on biomaterials and tissue engineering, self-healing structural materials and metamaterials. This list will keep on increasing as materials scientists, engineers and technologists respond to the demands of their colleagues in other disciplines, to help solve mankind's problems.

Future of Thermal Materials: Inspiration from Nature

Dr. Mohamad Asmidzam Ahamat

Thermal materials are used in any applications related to management of heat such as cooling or heating processes. Almost all man-made machines require efficient thermal management. For instance, car engines convert chemical energy in fossil fuel into mechanical energy through combustion. The heat produced in the engine cylinder is removed using cooling system to avoid overheating. Throughout this process, thermal materials will be taking care of the combustion and cooling of engines. Another example is the refrigerator at your home. A proper insulation system is required to isolate the cold spaces from its surrounding. Thermal materials that have ability to restrict transmission of heat are useful for this purpose.

Nature teaches us the best design to achieve a specific purpose. Animals, plants and other organisms that we can see today had survived series of challenges. They are undergoing evolution to ensure their survival. What we could learn from them to improve the efficiency of man-made technology, subsequently increase the quality of our life? This article discusses possibility to learn from nature in dealing with issues related to thermal engineering.

Penguins teach us on insulation

Penguins have a unique feather structure; with many short feathers and long after-feather. It is estimated that 96% of its feathers are filled by air. These combinations enabled penguins to avoid heat from leaving its body; 10 times more efficient than the wall of our house in protecting us from outside heat. If we are using `penguin feather insulation technology', we only need a smaller air conditioner unit which could reduce our electricity bill. To date, attempts to mimick penguin's insulation strategy are not yet fruitful.

White solar water heater

What is your perception if you see a white solar thermal collector on a roof? This colour is against your intuitive since our general knowledge tells us that black is a good heat absorber. If we learn from polar bears, its whitish fur covers almost all of its body. This fur is made of hollow hair filled with spongy materials. Surprisingly, the skin of polar bear is black. Radiation from the sun penetrates its layer of fur before being absorbed by its black skin. Then, this heat is stored in the fat under its skin. The fur also acts as an insulator to reduce heat losses from polar bears.

This concept in retaining heat is similar to what we required in solar thermal collector system. However, the effort to mimick this natural technology is limited by the ability of manmade materials to perform self-cleaning. Once we can produce a self-cleaning whitish fur, we may have a more efficient solar thermal collector. The question that we have to answer: Are we ready to install a furry solar thermal collector on our roof?

Collecting water from air

Thermal devices such as air conditioner and steam turbine power plant have a vital component called as condenser. In a condenser, hot vapour makes contact with cold solid surface before it turns to liquid. The effectiveness of condensation process is partly determined by the surface properties of condenser; hydrophilic surface is required to form liquid droplets and hydrophobic surface promotes flow of condensate. Desert battles have capabilities to collect liquid water from moisture in air. The back surface of these battles has alternate hydrophobic and hydrophilic regions that promote condensation and flow of liquid.

A condenser that adopt this strategy may need a smaller surface area, thus reduces its size. The challenge is on replicating the alternate hydrophilic and hydrophobic surface at a reasonable cost.

Variable thermal conductivity

Spider silk is well known due to its superior mechanical properties. Recently, scientist discovered that spider silk has different thermal conductivity under relaxed and stressed conditions. Furthermore, spider silk is more effective than copper in conducting heat. The lessons from spider silk could assist us in the development of polymer that may change its ability to conduct heat under compression, relaxed or stressed conditions. Isn't it elegant to have one stick that could be used interchangeably as insulator and conductor?

A significant effort to understand nature through numerous research activities revealed how organisms have been designed by its creator. Now, humans have a lot of information to replicate strategies use by animals in adapting to their environment. However, limitations on available engineering approach and limited options on materials hindered our effort to mimick these strategies. Advances in nanotechnology may provide a new hope to re-energise the effort in developing highly efficient thermal system by taking inspiration from nature. Advanced thermal materials are expected to contribute to development of thermal devices in Industrial Revolution 4.0.

The MILL CERTIFICATE for Polymeric Paints – Road to Discovery!

Melissa Chin Han CHAN [1,2*], Mohamad Kamal HARUN[1,2], Max Chong Hup ONG [2,3]
[1]Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia
[2]Institute of Materials, Malaysia, Suite 515, Level 5, Block A, Kelana Center Point (Lobby B), No.3, Jalan SS 7/19, Kelana Jaya, 47301 Petaling Jaya, Selangor, Malaysia.
[3]Norimax Sdn Bhd, No.2, Jalan TPP5/17, Taman Perindustrian Puchong, Seksyen 5, 47160 Puchong, Selangor, Malaysia

How do you know if the paint delivered to your project site is actually the product you ordered?

Why have you never asked for a Mill Certificate for the paints or plastic products you purchased?

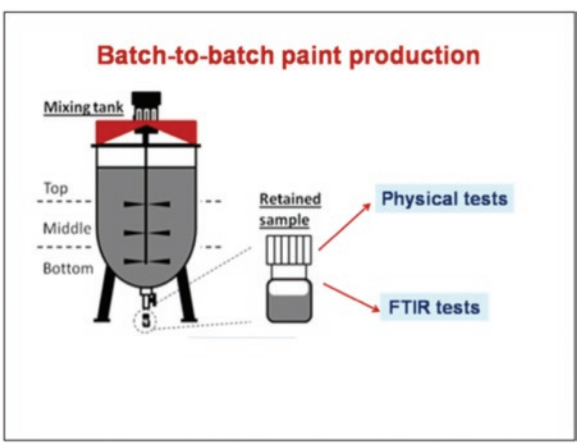
Do you know why your new house paint failed within 2 years despite claims of a '6-year performance paint'?

Corrosion is a naturally occurring process but it can be controlled. One of the best-practice strategies is to use industrial-grade polymeric paints for the reduction in the rate of corrosion on structures. NACE International estimated a total global loss of US$ 2.5 trillion in 2013 (3.4% of country's GDP) for corrosion control. Based on this projection, the cost of corrosion in Malaysia was estimated to reach nearly MYR 39.3 billion in 2015 (Malaysia's GDP in 2015 was MYR 1.16 trillion according to World Bank; average exchange rate from US$1 to Ringgit Malaysia was MYR 3.9 in 2015).

Local users have been suffering from high cost of repainting structures when the paints fail prematurely. One of the attributing factors for the failure of the coating may be the reformulation of polymeric coating. In other words, adulterated polymeric coating has been supplied to the job sites. This implies that the quality of supplied polymeric coating deviates from the submitted specifications for prequalification and tender purpose of projects.

In Malaysia, all the user gets is a quality certificate of conformity from the paint manufacturer stating that the product is what it is supposed to be. There is no simple way to verify or re-test the polymeric paints to confirm its actual chemical nature or origin. One has to put the product through numerous complicated and rigorous testings in a laboratory to verify the product formulation.

Due to serious premature coating failures at various PETRONAS facilities, **in 2016, PETRONAS Technical Standards (Technical Specification) (PTS 15.20.03) (Protective Coatings and Linings)** included **coating fingerprinting** as a requirement for qualification testing as well as for routine batch-to-batch paint production. To add, **registration of coating fingerprinting** under the Cost Reduction Alliance Initiative 2.0 **(CORAL 2.0)** was made due to sub-standard material supplies. It was found that many failures occured less than



3 years after application, which contributed 12 % of direct cause of Loss of Primary Containment (LOPC) in 2015.

A significant break-through to develop a method to provide a "Mill Certificate" for polymeric paints is showcased by a group of local researchers. The reproducibility and reliability of the techniques used and the final certificate give polymeric paints users an assurance of "what they buy is what they get".

A method was developed jointly by UiTM and the Institute of Materials, Malaysia (IMM) in collaboration with PETRONAS to provide a "Mill Certificate" (Coating Fingerprint Certificate) for polymeric paints. The complete certificate consists of two parts – physical analysis and structural analysis. Physical analysis (for viscosity, density, color code, non-volatile matter (by mass), mass of Zn metal/Total Zn, etc) is performed in an in-house laboratory during the paint manufacturing process, whereas structural analysis is carried out via Fourier-Transform Infrared (FTIR) immediately after the paint is produced in the paint factory.

Paint samples must pass both physical and structural analyses in order to be accepted. For FTIR structural analysis, a degree of similarity (*r*) of 0.900 or more is set as the acceptance criterion. If for whatever reason the paint is reformulated, there will be non-compliance of the test specifications. This will be shown accordingly in the Coating Fingerprint Certificate.

This is the first-of-its-kind fingerprint exercise in the world, which is up to the stage of mock execution.

Coating Fingerprint Certificate (updated on 2 Jan 2016)

Tentative Coating Fingerprint Certificate for 2-component intermediate materials of polymeric coatings

(Rev. 2.4 on 2nd January 2016)

Company name:	*e.g.* Company ABC	**Country:**	*e.g.* Malaysia
Certificate number:	*e.g.* epoxy/001/02Jan2016	**Date:**	*e.g.* 2 Jan 2016
Number pages:	*e.g.* 05		
Section 1: General information			
Product name:	*e.g.* EPOXY123	**Product type:**	*e.g.* epoxy, polyurethane, polyester, inorganic zinc, epoxy zinc, *etc*

Date of issue:	**Base material** (*e.g.* epoxy / epoxy zinc / polyacrylate / polyester / inorganic zinc)	**Curing agent / hardener** (*e.g.* amine / isocyanate / peroxide / ethyl-silicate)
Specify base material & curing agent	*e.g.* epoxy	*e.g.* amine
Trade name	*e.g.* Epikote123	*e.g.* Amine123
Generic	*e.g.* Epoxy	*e.g.* Hardener
Factory location	*e.g.* Shah Alam, Selangor	*e.g.* Shah Alam, Selongor
Batch number	*e.g.* 1234567A	*e.g.* 1234567B
Production date	*e.g.* 02 Jan 2016	*e.g.* 02 Jan 2016
Product technical data sheet number	*e.g.* TDS123A	*e.g.* TDS123B
Material safety data sheet number	*e.g.* MSDS123A	*e.g.* MSDS123B
Shelf life	*e.g.* 24 months	*e.g.* 24 months

Section 2: Test methods and results

Physical analyses

Parameters	**Method**	**Base material**		**Curing agent / hardener**	
		Specification with tolerance	**Test result**	**Specification with tolerance**	**Test result**
Viscosity	*e.g.* ASTM D4287 ASTM D5125 ASTM D562 ISO 2431 ISO 2884-1	*e.g.*….± 0.05 P	*e.g* 3.24 ± 0.02 P	*e.g.*….± 0.05 P	*e.g* 2.78 ± 0.03 P
Density	*e.g.* ISO 2811-4	*e.g.*….± 0.05 g cm^{-3}	*e.g.* 1.48 ± 0.03 g cm^{-3}	*e.g.*….± 0.05 g cm^{-3}	*e.g.* 0.943 ± 0.02 g cm^{-3}
Color code	*e.g.* BS 4800 RAL Color Standards	*e.g.* colour difference (d*E*) < 1	*e.g.* Light grey	*e.g.* colour difference (d*E*) < 1	*e.g.* clear
Non-volatile matter (by mass)	*e.g.* ISO 3251	*e.g.*….± 2 %	*e.g* 78 ± 2 %	*e.g.*….± 2 %	*e.g.* 99 ± 2 %
Weight Solid: Zn metal/Total Zn	*e.g* ISO14680-2 ISO 3549	*e.g.*….± 1 %	*e.g.* N/A for epoxy system	*e.g.*….± 1 %	*e.g.* N/A for epoxy system

Trade name and batch number of reference spectrum for curing agent / hardener	*e.g.* Amine123 & 1234567B-Reference

Notes:

1. Full range of FTIR spectra for both base and curing agent without automatic baseline correction and in absorbance mode are to be attached with this report (raw data).
2. Compliance to matching criteria values do not exclude meeting the requirements of other QA/QC checks *e.g.* drying time, gloss, hiding power *etc*.
3. Methods used shall reference latest published document.
4. This certificate is applicable to 1-pack or 2-pack systems.
5. This certificate can be submitted in CD or other digital formats.

The undersigned, hereby declare that all the analytical tests were performed according to the procedures herein and that this report represents a true and accurate record of the results obtained.

Authorized QA/QC Executive:-	**Validated by**:-
e.g. NAME Company ABC Sdn Bhd (123456-X) QC Department	*e.g.* COATING IMM Yoga Sugama Salim FP002 FINGERPRINT QC
Signature: *e.g.* Name	**Signature**: *e.g.* Yoga Salim
Date: *e.g.* 2 Jan 2016	**Date**: *e.g.* 2 Jan 2016
IMM membership member: (optional to be IMM member)	**IMM membership member**: *e.g.* O-1234

Section 4: Compulsory appendices (to be submitted in CD or other digital formats)	
Appendix 1	Overlay reference and sample FTIR spectra for base materials (**Note**: In addition, raw data of reference and sample FTIR spectra must be provided in two raw data files)
Appendix 2	Overlay reference and sample FTIR spectra for curing agent / hardener (**Note**: In addition, raw data of reference and sample FTIR spectra must be provided in two raw data files)
Appendix 3	Certificate of analyses which are relevant to the in-house standard testings
Appendix 4	Certificate of % purity of zinc by metal manufacturer for organic zinc and inorganic zinc

Note: submit certificate of % purity by manufacturer **Note:** applicable to organic and inorganic zinc only					
Structural analysis					
Infrared spectra	**Wet sample as supplied in can. Degree of similarity (r) $\geq$ 0.900**[*] (tentative tolerance = ± 0.002 or range of r = 1.000 – 0.898)				
	Method	**Base material**		**Curing agent / hardener**	
Base material: **epoxy** Curing agent: **amine**	ASTM D7588	600-4000 cm^{-1}	0.988	600-4000 cm^{-1}	0.970
		1000-1300 cm^{-1}	0.995	1000-1400 cm^{-1}	0.957
		700-900 cm^{-1}	0.996	N/A	N/A
Base material: **polyacrylate / polyester** Curing agent: **isocyanate**	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
		1600-1800 cm^{-1}		2000-2500 cm^{-1}	
		3000-3800 cm^{-1}		3000-3800 cm^{-1}	
Base material: **polyester** Curing agent: **peroxide**	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
		1600-1800 cm^{-1}		900-1200 cm^{-1}	
		2700-3100 cm^{-1}		N/A	N/A
Base material: **epoxy zinc** Curing agent: **amine**	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
		1000-1300 cm^{-1}		1000-1400 cm^{-1}	
		700-900 cm^{-1}		N/A	N/A
Base material: **inorganic zinc** Curing agent: **ethyl-silicate**	ASTM D7588	600-4000 cm^{-1}		600-4000 cm^{-1}	
		N/A	N/A	2700-3200 cm^{-1}	
		N/A	N/A	1000-1500 cm^{-1}	

[*] average results of triplicate analyses

Section 3: FTIR test details (as per ASTM D7588)			
Analyst & company name	*e.g.* Name & Company ABC Sdn Bhd		
Brand & model of FTIR	*e.g.* FTIR Brand XYZ & model: 2016		
Type of FTIR spectrophotometer	*e.g.* benchtop / mobile / handheld		
Benchtop: ATR crystal material	*e.g.* diamond, zinc selenide (ZnSe), germanium		
Spectral correction (circle) **Note:** correction is NOT recommended.	YES / NO [**Note**: if **YES**, please state the correction(s) made] *e.g.* automatic baseline correction		
Spectral range (cm^{-1})	*e.g.* 600 - 4000 cm^{-1}		
No. of sample scans (min 32)	*e.g.* 32 scans		
No. of background scans (min 32)	*e.g.* 32 scans		
Resolution (min 4 cm^{-1})	*e.g.* 4 cm^{-1}		
High sensitivity of correlation compare algorithm for matching ratio in absorbance mode	**Note:** Correlation compare algorithm of the FTIR software should depend on both x- (wavenumber) and y- (absorbance) vectors. High sensitivity compare algorithm, which analyzes the variations *via* summation of the squared differences of each variation from the overall mean OR equivalent, should be used.		
	Dependence on BOTH x- and y- vectors (circle)	YES / NO	High sensitivity compare algorithm (circle)	YES / NO
Trade name and batch number of reference spectrum for base material	*e.g.* Epikote123 & 1234567A-Reference		

Aircraft Composite Material: New Challenges in Aviation

Dr. Khairul Dahri Mohd Aris

Composite materials have started to replace traditional aluminium alloys in most aerospace structures. A number of military applications and small aircrafts have already benefitted from this material due to its superior engineering properties. Boeing and Airbus aircraft manufacturers are racing to be the leader in the usage of this material.

According to the Royal Society of Chemistry (RSC), composite materials are defined as the combination of two or more constituent materials that possess different composite properties (including physical and chemical properties), which when combined, produce a superior and unique material having different characteristics. The use of composite materials has opened new challenges in damage detection and repair schemes, among others.

The technique used to detect structural anomalies on aircraft is known as non-destructive inspection (NDI), whereby, inspection is carried out without disturbing the structure. In other words, the structure will still be intact after the test is completed. A basic NDI is the tap test. In this test, damage is detected simply by tapping on the surface of the component. More advanced procedures such as ultrasonic, thermography, laser shearography, phase array, and several others will give 3D damage perspectives. Once the damage has been identified, the defects will be removed and replaced.

New generation commercial aircrafts like Boeing 787 Dreamliner and Airbus A350 are expanding its composite contents. As such, there are opportunities to carry out composite repair works on damaged primary structures and non-structural components. The composite repair market is projected to increase alongside the rising cost of composite part replacements. The composite repair market comprises structural, semi structural and cosmetic repairs. These are based on the type of damage incurred. Damage can be repaired using several methods, including wet and dry lay-up cured at room temperature, high temperature, or very high temperature curing. Most of the damage requires pressure to fully cure the resin and to ensure strong bonding. A hot bonder is used to control the vacuum pressure and temperature until the repair area is cured.

Both NDI and composite repair require competent staff members to work on the composite structures. The staff members must have certification or license to practice their craft. Acquiring a certificate from the American Society of Non-Destructive Testing (ASNT) is one way to qualify for NDI work. There are three levels - Level 1, Level 2 and Level 3. Those who acquire the highest level can write procedures and conduct trainings.

As for composite repair, no proper certification is available yet. However, the US-based Federal Aviation Administration is in the process of developing certification for composite repair work, similar to NDT certification. At present, composite repair technicians and/ or engineers need to be properly trained via courses offered by airlines or training institutions. In Malaysia, UniKL MIAT conducts aircraft composite training programs since 2006 based on Part 147 Approved Training Center by the Civil Aviation Authority Malaysia (CAAM).

All photos are courtesy of Dr. Khairul Dahri Mohd Aris, Principal Trainer of Aircraft Composite Repair, UniKL MIAT

Contact
Address: UniKL MIAT, 2891, Jalan Jenderam Hulu 43800 Dengkil, Selangor
Phone No.: +60126237914 Email: khdahri@unikl.edu.my

Graphene-based Supercapacitors – a Breakthrough in Energy Storage Limit

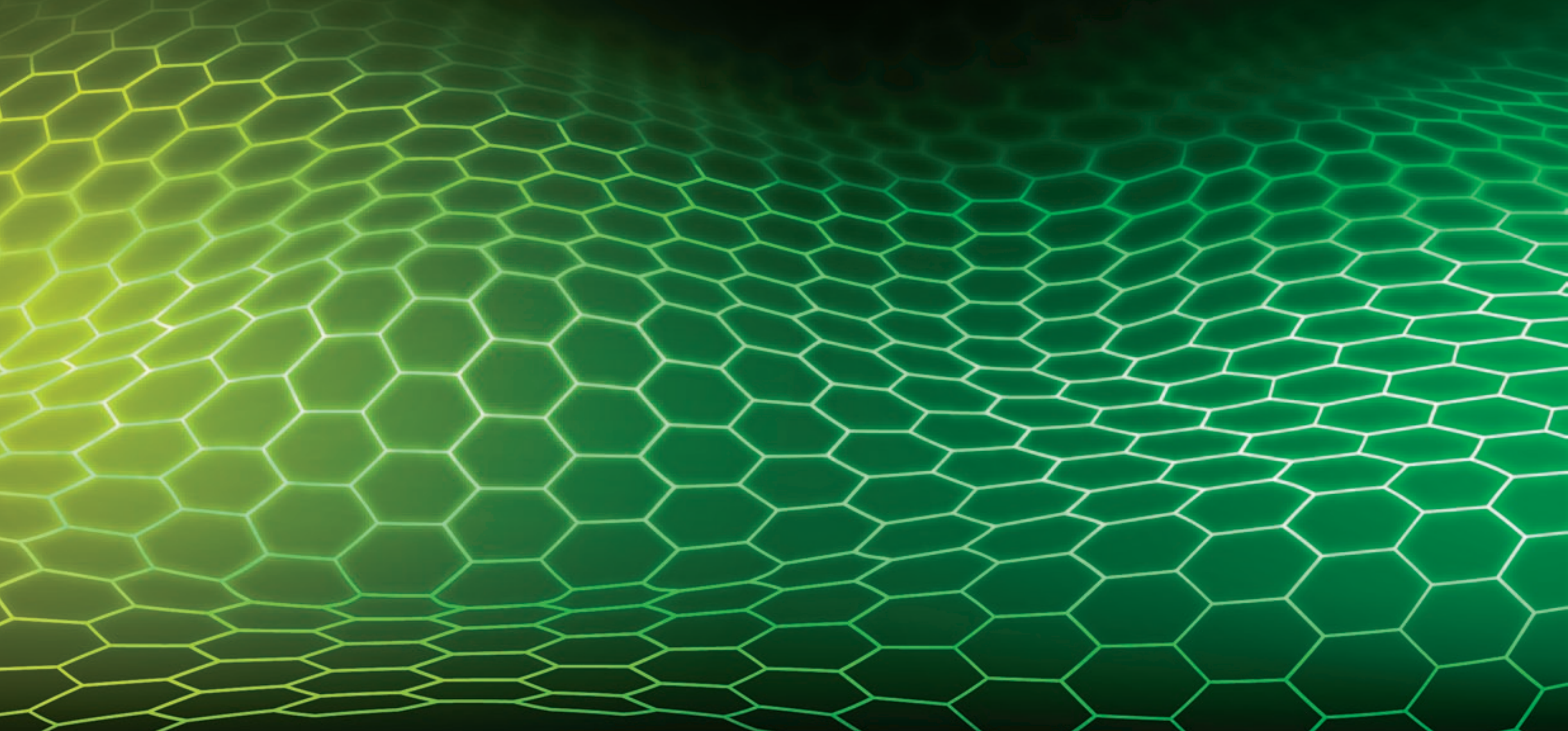
Author: Syahril Idris, Fadillah Iskandar, Mahadhir Yunus, Mohd Afandi Amir, Muhammad Rahmad Mohd Ashari, Nor Suriyanti Osman, Emi Fariza

The introduction of the smart home, smart factory, and electric vehicle have demanded energy storage solutions such as batteries and capacitors to catch-up with the current technology. For a while now, researchers have been struggling to provide efficient energy storage using optimal designs.

As of today, batteries that need a huge amount of energy storage must be very large and heavy. Energy is then released relatively slowly. Capacitors, on the other hand, are able to be charged and can release energy very quickly. However, they hold much less energy than batteries. In order to overcome the limitation of energy storage, the use of Graphene nano-materials is now sought after. These materials have high relative surface area, excellent electrical conductivity, good elastic properties, and remarkable mechanical strength. In addition, they are lightweight, cost-effective, and have high charge and discharge rates.

Supercapacitor - what is it?

Supercapacitors, also known as ultracapacitors, are able to hold hundreds of times the amount of electrical charge as standard capacitors and are therefore suitable replacements for electrochemical batteries in many industrial and commercial applications. Supercapacitors also work in very low temperatures – a condition that can prevent many types of electrochemical batteries from working. For these reasons, supercapacitors are already used in emergency radios and flashlights, where



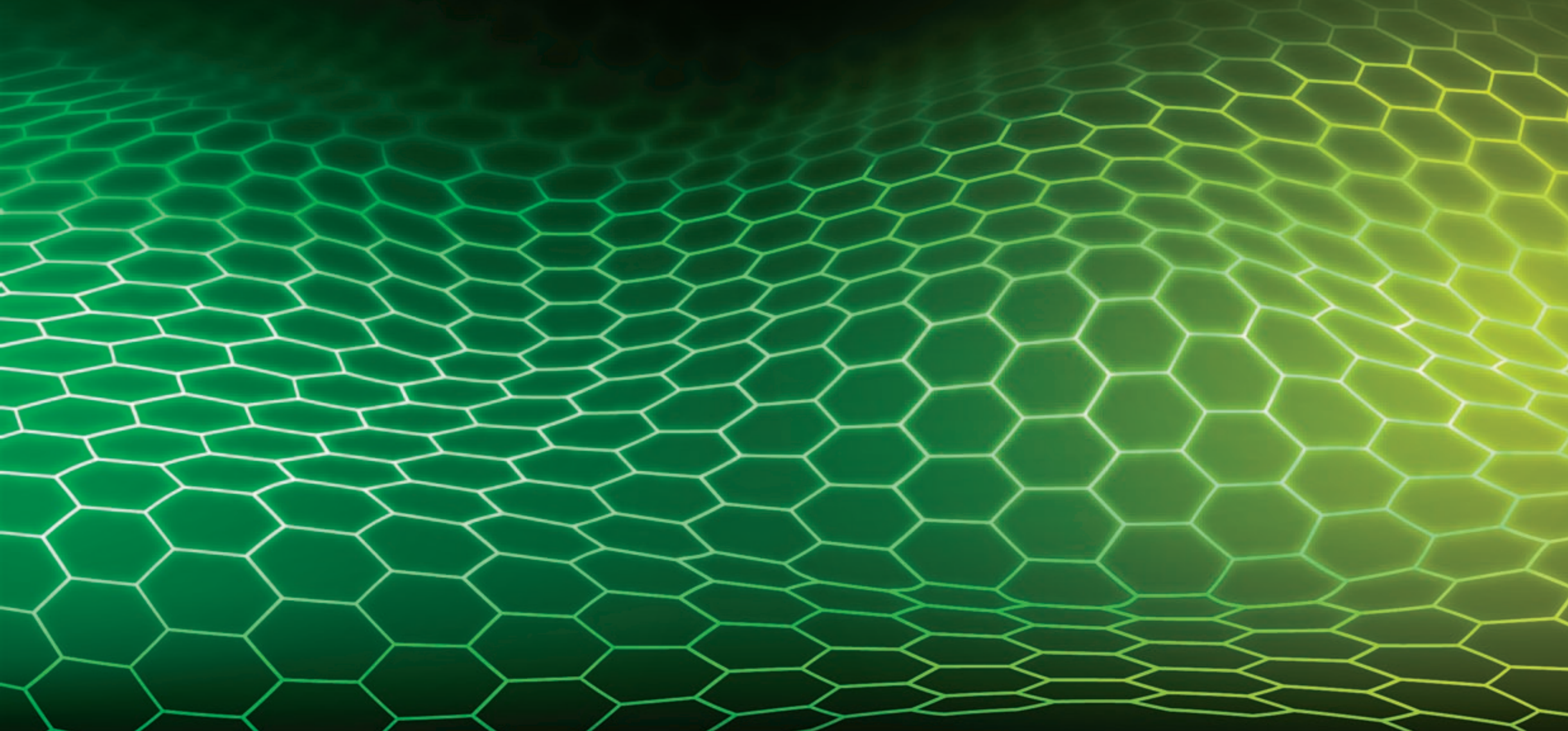
energy can be produced kinetically (by winding a handle, for example) and then stored in a supercapacitor for the device to draw upon.

A conventional capacitor is made of two layers of conductive materials (eventually becoming positively and negatively charged) separated by an insulator. What dictates the amount of charge a capacitor can hold is the surface area of the conductors, the distance between the two conductors and the dielectric constant of the insulator. Supercapacitors are slightly different in that they do not contain a solid insulator. Instead, the two conductive plates in a cell are coated with a porous material - the most commonly used is activated carbon. The cells are immersed in an electrolyte solution. Ideally, the porous material has an extremely high surface area - 1 gram of activated carbon can have an estimated surface area equal to that of a tennis court. Because the capacitance of a supercapacitor is dictated by the distance between the two layers and the surface area of the porous material, very high levels of charge can be achieved.

Graphene is a semi-metal with a small overlap between the valence and the conduction bands (zero bandgap material). It is an allotrope (form) of carbon consisting of a single layer of carbon atoms arranged in a hexagonal lattice. The supercapacitor consists of two layers of Graphene with an electrolyte layer in the middle. Graphene films have strong properties and are able to release a large amount of energy in a short time lapse.

What is the value of the supercapacitor?

Supercapacitors, unfortunately, are currently very expensive to produce. At present, the scalability of supercapacitors in the industry is limiting the application options, for, energy efficiency is offset against cost efficiency. As Malaysia realises the need to push forward a multitude of development priorities, especially on the potential of Graphene both in terms of "how to compete" and "where to compete", the National Graphene Action Plan 2020 (NGAP 2020) is geared up. The Plan lays out priority applications that will be beneficial to the country. Moving forward, Nano Malaysia Berhad (Nano Malaysia) has been appointed as the lead agency to execute the NGAP 2020. Among the efforts to be extended are the nurturing of nanotechnology growth and commercialisation. The eventual goal is to develop a Graphene ecosystem that addresses the concerns of end users, experts, and eventually producers.



High Vacuum Scanning Probe Microscope (SPM)

S.Y. Kok*, M.T. Soo and K.Y. Tay*
Hi-Tech Instruments Sdn. Bhd. 19, Jalan BP 4/8, Bandar Bukit Puchong, 47120 Puchong, Selangor, Malaysia
*Corresponding authors: Email danny_kok@htimail.com.my, kytay@htimail.com.my

Scanning probe microscopy (SPM) is a microscopic technique that detects various physical interactions between a probe and sample, and measures surface shape and physical properties of microscopic area. Physical interactions detected include tunnel effect, atomic force, magnetic force, adhesive force and friction force (refer Fig. 1).

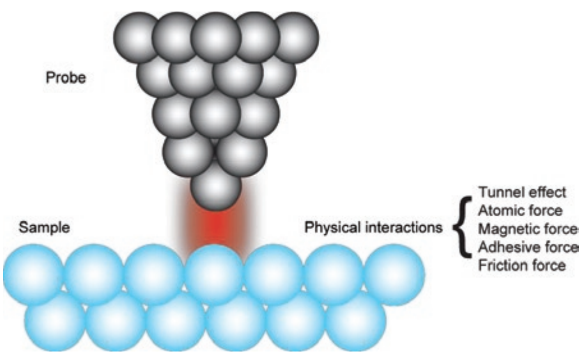


Figure 1 The various physical interactions between the SPM probe and sample surface.

The schematic diagram in Fig. 2 gives an overview of the capability of SPM not only for the topography analysis but also in a wide range of physical properties evaluation, namely mechanical properties, thermal properties, electrical properties, magnetic properties, and processing. The measurement and physical properties evaluation are applicable for all kind of samples: the organics and polymers; the semiconductor electronics; the inorganic materials; the metal, dielectric and magnetic substances; and the biological sample.

Since the working principle of SPM is based on the interaction between probe and sample surface, the environment of the interaction plays a crucial role in determining the surface and physical properties measurement. The environmental control unit of the Hitachi SPM supports various environmental needs, including high vacuum, liquid and gas (refer Fig. 3). In these different environments, the gas atmosphere, humidity and temperature can be manipulated for different measurement needs.

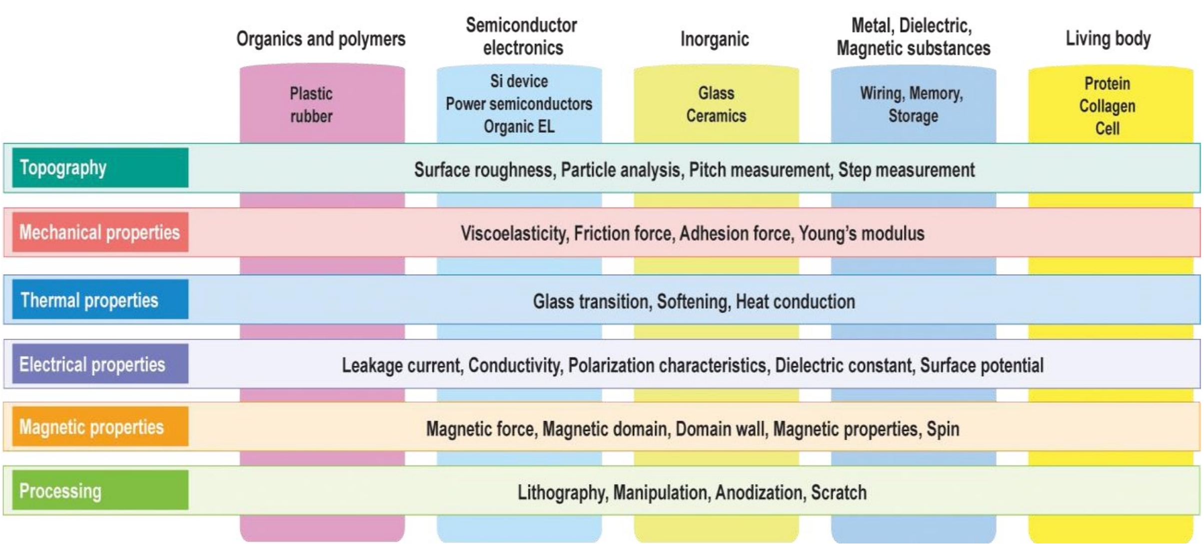


Figure 2 Overview of SPM for measuring and evaluating physical properties applicable for different disciplines.

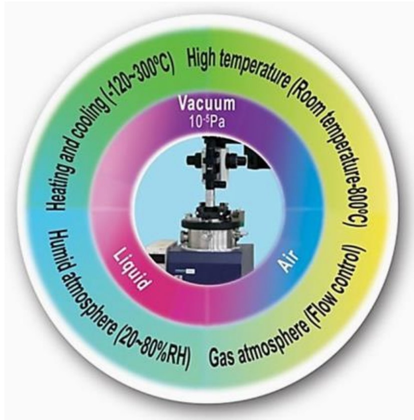


Figure 3 Environmental controls of the Hitachi SPM.

In particular, operation in high vacuum environment has advantage because the negative impacts caused by the absorbed water and atmospheric gas can be reduced or eliminated. Two examples are described in Fig. 4 to elucidate the significance of the measurement in high vacuum environment.

The schematic diagram in Fig. 4a illustrates that the adsorbed water (moisture) in atmospheric air would affect the interaction between the SPM probe and sample surface. Since the dielectric constant of water is approximately 80, this would result in an undesired impact on the electrical properties measurements. For example, the resolution may decrease by increasing effective area of electrical contract of the probe by adsorbed water. The semiconductor carrier mapping shown in Fig. 4a was performed by scanning non-linear dielectric microscope (SNDM), which is useful for semiconductor dopant concentration distribution observation. It is clearly observed that the doped region as designed for *P* type and *N* type semiconductor has improved resolution in vacuum than in air, and concentration differences in the *N+* region are clearly observed.

When the SPM measurement involves the vibration of cantilever, viscous resistance by gas molecules in air affects the sensitivity of output detection (Fig. 4b). High sensitivity measurements can be performed by combining *Q* value control in a vacuum. The nano-magnetic hexagonal lattice structure images obtained by magnetic force microscope (MFM), shows that the improved sensitivity and resolution for magnetic domain imaging in vacuum. The *N* pole and *S* pole of the sample surface can be clearly distinguished.

In summary, high vacuum SPM with environment control capabilities enables an accurate investigation of the surface and physical properties under a controlled environment without the interferences of gas and water molecules, which offers significant improvement in resolution and sensitivity for electrical and magnetic property measurements.

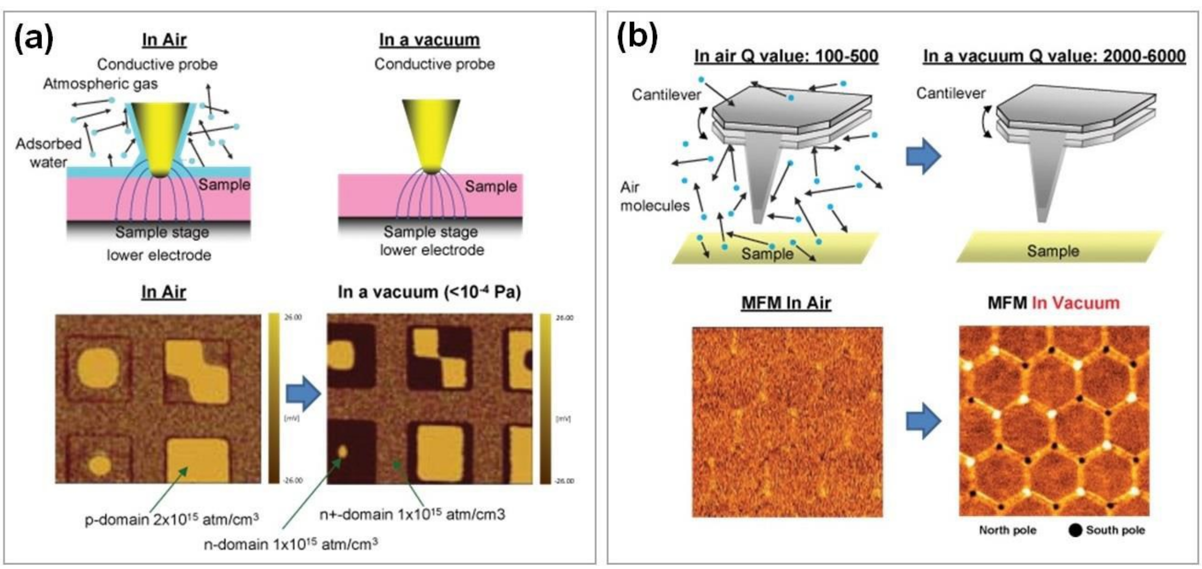


Figure 4 (a) Semiconductor carrier distribution measurements in air and in vacuum. (b) Magnetic measurement sensitivity measurements in air and in vacuum.

MoU Signing Ceremony

Between MBOT and Technology Expert Panel

PUTRAJAYA, 1 June 2018 - An MOU signing ceremony between the Malaysia Board of Technologist (MBOT) and Technology Expert Panels (TEP) which was held at MBOT office, signifies the joint aspirations of MBOT and TEP for a good symbiotic collaboration ahead.

The President of MBOT in his welcoming remarks expressed his confidence that with tireless efforts of both the TEP and MBOT, this mutual collaboration will grow stronger and yield greater results for a brighter future. "We would like to get your commitment to drive MBOT together with us as we're shaping MBOT to be the professional body of the future, driven by the experts', he added.

The MOU were represented by the following prominent figures as the signatory:

- YBhg Tan Sri Dato' Academician (Dr.) Ts. Ahmad Zaidee Bin Laidin, FASc, President, Malaysia Board of Technologist (MBOT);
- YBhg Dato' Dr Haji Amirudin Bin Abdul Wahab, Chief Executive Officer, Cybersecurity Malaysia;
- YBhg Dato' Madani Sahari, Chief Executive Officer, Malaysia Automotive Institute (MAI);
- YBhg Dato' Jurey Latiff Rosli, Chairman, Creative Content Industry Guild (CCIG);
- YBhg Prof Dato. Sr. Dr. Haji Omar Haji Osman, Vice Chancellor, DRB-HICOM University;

MoU Exchange between MBOT and Institute of Materials, Malaysia (IMM)

MoU Exchange between MBOT and DRB-HICOM University

MoU Exchange between MBOT and MARA Corporation Sdn. Bhd.

- Sinnapar Perumal,
  Accountable Manager,
  Allied Aeronautics Training Centre Sdn. Bhd;

- Mohd Azmi Mohd Nor,
  President of IMM,
  Institute of Materials, Malaysia (IMM);

- Sharifah Zaida Nurlisha,
  President,
  Malaysia Oil & Gas Services Council (MOGSC);

and

- Muhammad Lukman Bin Musa,
  Acting Chief Executive Officer,
  MARA Corporation Sdn Bhd.

Moving forward, MBOT online assessment will kick start in the month of July 2018. The pilot assessment will be open to four (4) technology fields namely Automotive Technology, Cyber Security Technology, Aerospace & Aviation Technology and Oil & Gas Technology. Subsequently, all fast track applications will be closed by 30th June 2018. Hopefully, the professional assessment for these 4 technology fields which is conducted by MBOT together with the TEP and industry, will manage to create a better acceptance and recognition of Professional Technologist and Certified Technician amongst the industry players.

Lastly, the MOU indicates that MBOT and TEP agree in principal to work hand in hand in developing the related technology fields and uplifting the status of technologists and technicians in Malaysia.

MoU Exchange between MBOT and Malaysia Oil & Gas Services Council


MoU Exchange between MBOT and Allied Aeronautics Training Centre Sdn. Bhd


MoU Exchange between MBOT and Content Industry Guild (CCIG)


MoU Exchange between MBOT and Malaysia Automotive Institute (MAI)

MoU Exchange between MBOT and CyberSecurity Malaysia

Among MBOT's Board Members
present at the ceremony

Presiden MBOT menerima
cenderahati daripada
DRB Hicom University

23 Fields of Technology

What is MBOT's Recognized Technology Fields? To-date, MBOT has recognized 23 Technology and Technical Fields. These technology fields are not permanent and will dynamically change based on the rapid growth of technology. Each Technology Fields has gone through rigorous verification and requirements study before it was being approved by the Board and recognised as MBOT Technology and Technical Fields.

Each Technology and Technical fields was defined by MBOT's Technology Expert Panel which consists of representative for the industry, relevant government agency and academia. The Key Area for each Technology and Technical Fields was also defined properly to cover the wide angle of Technology Fields and its implementation in the industry.


Electrical and Electronic Technology (EE)


Information and Computing Technology (IT)


Chemical Technology (CM)


Telecommunication and Broadcasting Technology (TB)


Biotechnology (BT)


Building and Construction Technology (BC)


Resource Based, Survey and Geomatics Technology (RB)


Manufacturing and Industrial Technology (ME)


Agro-based Technology (AF)


Cyber Security Technology (CS)


Transportation and Logistic Technology (TL)


Material Technology (MT)


Marine Technology (MR)


Maritime Technology (MI)


Atmospheric Science and Environment Technology (AC)


Green Technology (GT)


Oil and Gas Technology (OG)


Automotive Technology (AT)


Aviation and Aerospace Technology (AV)


Food Technology (FT)


Nano Technology (NT)


Nuclear and Radiological Technology (NR)


Art Design and Creative Multimedia (AM)