ISETC2025

UNIVERSITI TEKNOLOGI MARA

ISETC2025

2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

TENSILE PROPERTIES OF CARBON NANOTUBES REINFORCED EPOXY MATRIX COMPOSITES

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Abstract: This study investigated the tensile properties of carbon nanotubes (CNT) reinforced epoxy matrix composites fabricated using the hand lay-up technique. CNTs were incorporated at different weight percentages (0.5 wt%, 1.0 wt.% and 1.5 wt.%) into epoxy resin. Tensile test were performed according to ASTM D3039 to assess the mechanical performance. Results showed that the 1.0 wt.% CNT sample exhibited the highest strength of 25.40 N/mm^2 compared to 0.5 wt.% MWCNT sample (15.75 N/mm^2). However, the 1.5 wt.% sample experienced reduced in strength (22.59 N/mm^2), attributed to CNT agglomeration and bubble formation during mixing process. Interestingly, the pure epoxy sample showed the highest tensile strength (38.20 N/mm^2) might be due to the lack of defect. These findings demonstrate that while CNT can enhance the mechanical performance of epoxy composite, their effectiveness is limited by processing quality and interfacial bonding.

Keywords**:** *Carbon nanotubes, epoxy matrix, tensile strength, composite materials, hand lay-up*

INTRODUCTION

Composite materials have drawn attention, especially to the manufacturers due to their advantages and benefits. They are extensively utilized in industries due to their lightweight, high strength, rigid and multifunctional applications (Khan et al., 2024; Simões, 2024). Epoxy resins are extensively utilized in aerospace application, including aircraft and space shuttles due to their superior mechanical strength, chemical resistance, and lightweight characteristics (Al-Saleh & Sundararaj, 2011). Among various reinforcements, carbon nanotubes (CNTs) offer exceptional stiffness, tensile strength and thermal stability, making them ideal for advanced nanocomposites. Carbon nanotubes can be categorized based on the number of concentric cylindrical layers they possess. Those consisting of a single cylindrical layer are known as single-wall carbon nanotubes (SWCNTs), first reported in 1993 (Iijima & Ichihashi, 1993). In contrast, structures with multiple concentric layers are referred to as multiwall carbon nanotubes (MWCNTs), initially discovered by Iijima in 1991 (Iijima, 1991). The integration of CNTs into epoxy resins can significantly improve mechanical performance by uniformly dispersed and well-bonded to the matrix. However, achieving uniform dispersion of CNTs within the epoxy matrix remains a critical challenge, as agglomeration can compromise interfacial bonding and hinder effective load transfer. This study aims to investigate the influence of CNT on the tensile properties of epoxy composites. By understanding these factors, the development of high performance nanocomposites for advances structural application can be further optimized.

MATERIALS AND METHODS

The composite specimen were fabricated using hand lay-up process as shown in Figure 1. Miracast 1517 (A/B) epoxy resins, supplied by Miracon (M) Sdn Bhd , were used as the matrix or binding agent in this study. The resins system consist of two component, Miracast 1517 (A) for the epoxy and Miracast 1517 (B) for the hardener. The reinforcement material comprised multi-wall carbon nanotubes (CNTs) with a purity of >95% , a diameter of 11 nm and a length 10 ụm. These CNTs were produced using a catalytic vapour deposition (CVD) technology and supplied by CNano Tech, China. They were incorporated into the epoxy matrix at different weight percentages of 0.5 wt%, 1.0 wt.% and 1.5 wt.%. The density of these CNTs is 2.2754 g/cm^3. The samples were cast into aluminium moulds and cured at room

temperature. Tensile test were conducted using a Shimadzu Universal Testing Machine (UTM) under a crosshead speed of 2 mm/min, in accordance with ASTMD3039. Figure 2 shows the final samples at different weight percentages of MWCNTs and also sample of pure epoxy as for references.



Figure 1. Preparing sample using Hand Layup Process

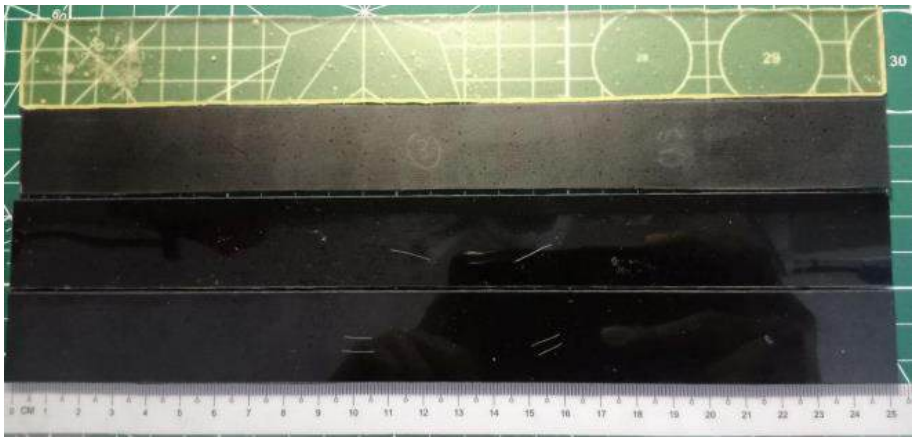


Figure 2. Sample size according to the ASTM D3039 requirement for tensile test

RESULTS AND DISCUSSION

Figure 3 depicts the typical tensile stress-strain graph of CNTs/Epoxy composites. From the graph, 1.0 wt.% of CNTs achieved the highest tensile strength (25.40 N/mm^2), outperforming the 0.5 wt.% CNTs sample (15.75 N/mm^2). However, 1.5 wt.% CNTs sample showed a decrease in strength (22.59 N/mm^2). All CNT-reinforced samples show steep gradient in elastic region but lower strain at failure suggest more brittle behavior. The potential cause for this problem is poor handling when preparing the samples, and incomplete mixing of the solutions that lead to the bubbles formation. Effective dispersion requires separating entangled CNTs and stabilizing them in the polymer matrix to prevent agglomeration (Nurazzi et al., 2021). CNTs have a very large surface area and are long and thin. So, it is difficult to spread them evenly throughout the epoxy resin. Unlike other materials like carbon black or graphite which have smaller surface area , CNTs tend to clump together instead of mixing well (Turan et al., 2022). To create a homogenous mixture and prevent agglomeration, the CNTs must be dispersed effectively inside the epoxy resin. The final composite material may contain voids due to places where the resin cannot penetrate, which can be caused by improper mixing or unequal dispersion of CNT. This agglomeration induced stress concentration, thus reducing the mechanical properties (Zakaria et al., 2017). Interestingly, the pure epoxy sample recorded the highest tensile stress (38.20 N/mm^2), undergoes significant plastic deformation before failure, indicate ductile behavior, possibly due to absence of defects. These defects acted as stress concentrators, diminishing the benefits of CNT reinforcement. The

findings underscore the importance of uniform CNT dispersion and defect control to fully exploit the mechanical advantages of CNTs in polymer matrices. Table 1 shows the Tensile data characteristics for CNTs/Epoxy composites.

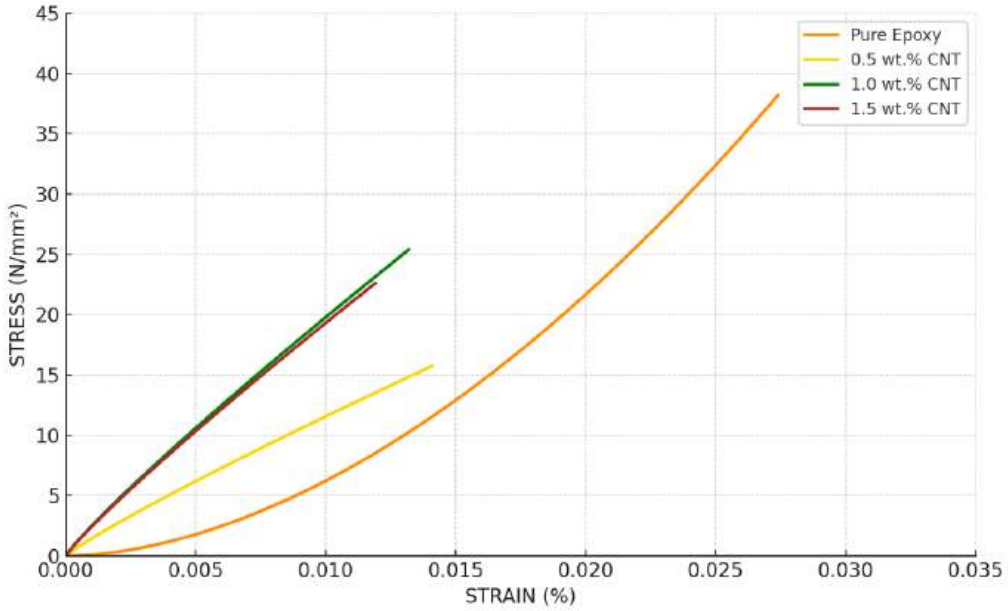


Figure 3. Typical tensile stress-strain graph CNTs/Epoxy composites

Table 1. Tensile data characteristics for CNTs/Epoxy composites

Samples	Maximum Force (kN)	Maximum Stress (N/mm^2)(UTS)	Maximum Strain (%)
Pure Epoxy	2.87 ± 0.46	38.20 ± 6.08	2.74 ± 0.72
0.5 wt.% CNT	1.18 ± 0.057	15.75 ± 0.76	1.41 ± 0.066
1.0 wt.% CNT	1.90 ± 0.37	25.40 ± 4.89	1.32 ± 0.28
1.5 wt.% CNT	1.69 ± 0.10	22.59 ± 1.38	1.19 ± 0.093

CONCLUSIONS

The study found that by incorporating 1.0 wt.% CNTs into the epoxy matrix yielded the highest tensile strength, indicating optomal dispersion and efficient stress transfer. However, strength decreased at 1.5 wt.% CNT, may be due to agglomeration and void formation, highlighting dispersion challenges at higher loading. Pure epoxy outperformed all CNT-reinforced sample might be because it lacked processing defect such as bubbles. The addition of CNTs increased stiffness but reduced ductility, shifting the material behavior toward brittleness. The 1.0 wt.% CNT sample achieved a good balance between strength and moderate ductility, suggesting it as the optimal loading for mechanical enhancement. These results emphasize the importance of proper dispersion techniques and future research should focus on advanced method like ultrasonication or CNT functionalization to improve matrix interaction and composite performances.

REFERENCES

Al-Saleh, M. H., & Sundararaj, U. (2011). Review of the mechanical properties of carbon nanofiber/polymer composites. *Composites Part A: Applied Science and Manufacturing*, *42*(12), 2126–2142. https://doi.org/10.1016/j.compositesa.2011.08.005

Iijima, S. (1991). Helical Microtubules of Graphitic Carbon. *Nature*, *354*, 56–58.

Iijima, S., & Ichihashi, T. (1993). Single-shell carbon nanotubes of 1-nm diameter. *Nature*, *363*(6430), 603–605. https://doi.org/10.1038/363603a0

Khan, F., Hossain, N., Mim, J. J., Rahman, S. M., Iqbal, M. J., Billah, M., & Chowdhury, M. A. (2024). Advances of composite materials in automobile applications – A review. *Journal of Engineering Research (Kuwait)*, *February*. https://doi.org/10.1016/j.jer.2024.02.017

Nurazzi, N. M., Asyraf, M. R. M., Khalina, A., Abdullah, N., Lee, C. L., Aisyah, H. A., Nor, M., Norrrahim, F., Ilyas, R. A., Harussani, M. M., & Ishak, M. R. (2021). Nanotube-Reinforced Polymer Composite : An Overview. *Polymers*, *13*(7), 1047.

Simões, S. (2024). High-Performance Advanced Composites in Multifunctional Material Design: State of the Art, Challenges, and Future Directions. *Materials*, *17*(23). https://doi.org/10.3390/ma17235997

Turan, F., Guclu, M., Gurkan, K., Durmus, A., & Taskin, Y. (2022). The effect of carbon nanotubes loading and processing parameters on the electrical, mechanical, and viscoelastic properties of epoxy-based composites. *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, *44*(3). https://doi.org/10.1007/s40430-022-03393-2

Zakaria, M. R., Abdul Kudus, M. H., Akil, H. M., & Zamri, M. H. (2017). Improvement of fracture toughness in epoxy nanocomposites through chemical hybridization of carbon nanotubes and alumina. *Materials*, *10*(3). https://doi.org/10.3390/ma10030301

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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Setuju.

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