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Intelligent Manufacturing and Mechatronics

Selected Articles from iM3F 2023, 7–8
August, Pekan, Malaysia

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Preface

The fourth edition forum of the Innovative Manufacturing, Mechatronics and Materials Forum 2023 (iM3F 2023) organized by Universiti Malaysia Pahang Al-Sultan Abdullah through its Faculty of Manufacturing and Mechatronic Engineering Technology was held on 7 and 8 August 2023. The main field focuses on Manufacturing, Mechatronics as well as Materials.

About 95 submissions were received during iM3F 2023 and were reviewed in a single-blind manner, and 48 papers were advocated by the reviewers to be published in this Springer Proceedings of Materials. The editors would like to express their gratitude to all the authors who submitted their papers. The paper published in this proceeding has been thoroughly reviewed by the appointed technical review committee which consists of various experts in the field of materials and manufacturing engineering.

The conference had brought a new outlook on cutting-edge issues shared through keynote speeches by Assoc. Prof. Ir. Dr. Haji Nik Mohd Zuki Nik Mohamed, Prof. Eng Hwa Yap and Prof. Gian Antonio Susto.

Finally, the editors hope that readers find this volume informative as we thank Springer Proceedings in Materials for undertaking this volume publication. We also would like to thank the conference organization staff and the international program committees' members for their hard work.

Pekan, Pahang, Malaysia
November 2022

Radhiyah Abd. Aziz
Zulhelmi Ismail
A. K. M. Asif Iqbal
Irfan Ahmed

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Carbon Nanotube-Reinforced Polymer Composites for Biomedical Applications

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Abstract

The utilization of carbon nanotube-reinforced polymer composites (CNT-RPCs) has been recognized as a significant breakthrough in the field of material science, owing to their exceptional amalgamation of characteristics. The incorporation of carbon nanotubes (CNTs) into a polymer matrix results in a composite material that combines the notable mechanical strength, electrical conductivity, and thermal stability exhibited by CNTs with the inherent flexibility of polymers. The process of integration leads to the development of improved composite materials that are suitable for a wide range of applications, and possess the ability to modify their properties according to specific application requirements. CNT-RPCs have established a distinct position within the field of biomedicine, specifically in the domains of bone implantation, tissue engineering, regenerative medicine, and drug delivery. These cells offer notable benefits including biocompatibility, electrical conductivity, and efficient drug distribution. Moreover, the incorporation of carbon nanotubes (CNTs) into polymers has demonstrated significant advancements in the fields of electronics, aerospace, and medicine. Cutting-edge modeling techniques utilizing deep learning are currently being implemented to enhance and

optimize these composite materials. The present analysis provides an in-depth exploration of the advancement, attributes, and utilization of carbon nanotube-reinforced polymer composites (CNT-RPCs) in the field of biomedicine. Notably, recent advancements, obstacles, and prospects pertaining to this revolutionary material are emphasized.

References

1. Zhang H, Saberi A, Heydari Z, Baltatu M (2023) Bredigite-CNTs reinforced Mg-Zn Bio-composites to enhance the mechanical and biological properties for biomedical applications. *Materials* 16:1681

[Article](#) [PubMed](#) [PubMed Central](#) [Google Scholar](#)

2. Wang L, Choi J (2022) Highly stretchable strain sensors with improved sensitivity enabled by a hybrid of carbon nanotube and graphene. *Micro and Nano Syst Lett* 10:17

[Article](#) [Google Scholar](#)

3. Mun SG, Choi HW, Lee JM et al (2020) RGO nanomaterial-mediated cancer targeting and photothermal therapy in a microfluidic co-culture platform. *Nano Convergence* 7:10

[Article](#) [PubMed](#) [PubMed Central](#) [Google Scholar](#)

4. Cho YW, Park JH, Lee KH et al (2020) Recent advances in nanomaterial-modified electrical platforms for the detection of dopamine in living cells. *Nano Convergence* 7:40

[Article](#) [PubMed](#) [PubMed Central](#) [Google Scholar](#)

5. Fazi L, Andreani C, D'Ottavi C, Duranti L, Morales P, Preziosi E, Prioriello A, Romanelli G, Scacco V, Senesi R, Licoccia S (2023) Characterization of conductive carbon nanotubes/polymer composites for stretchable sensors and transducers. *Molecules* 28:1764

[Article](#) [PubMed](#) [PubMed Central](#) [Google Scholar](#)

6. May Shian HL, Syed Kamarudin SNH, Ishak I, Jamaludin AS, Abdul Manaf AR, Mohd Zawawi MZ (2021) Laser-assisted thermal imprinting of Glass Guided Mode Resonant (GMR) optical filter. *J Mod Manufact Syst Technol* 5:63–70

[Article](#) [Google Scholar](#)

7. Hund-Rinke K, Hümmeler A, Schlinkert R et al (2019) Evaluation of microbial shifts caused by a silver nanomaterial: comparison of four test systems. *Environ Sci Eur* 31:86

[Article](#) [Google Scholar](#)

8. Miao Y, Chen Q, Li Y, Zhuo D, Wang R (2023) Tribological properties of carbon nanotube/polymer composites: A mini-review. *Front Mater* 2023:1129676

[Article](#) [Google Scholar](#)

9. Abdullah NAS, Abdullah FF, Sufian AH, Abidin ANSZ, Jamaludin AS, Razali MNM (2022) Effect of degradation by temperature onto nitrile rubber elastomer mechanical properties. *Mater Today Proc* 48:1941–1946

[Article](#) [Google Scholar](#)

10. Navya PN, Daima HK (2016) Rational engineering of physicochemical properties of nanomaterials for biomedical applications with nanotoxicological perspectives. *Nano Convergence* 3:1

[Article](#) [PubMed](#) [PubMed Central](#) [Google Scholar](#)

11. Md Kamil NH, Jamaludin AS, Mhd Razali MN, Abd. Ghaffar ANA (2022) Temperature and heat flow analysis in a drying chamber through finite element method. In: Lecture notes in mechanical engineering. Springer Nature, Singapore, pp 309–316

[Google Scholar](#)

12. Letchumanan SM, Tajul Arifin AM, Taib I, Nor Salim NA (2023) Computational fluid dynamic analysis on carbon fibre reinforced polymer wrapped on defected oil and gas piping system using solidwork flow simulation. ARFMTS 101:197210

[Google Scholar](#)

13. Lee H, Binti Kamarudin SN, Ishak I, Manaf AR, Jamaludin AS, Shaharudin MAH, Zawawi MZ (2021) Feasibility study of wafer scale laser assisted thermal imprinting of glass nanostructures. In: Lecture notes in mechanical engineering. Springer, Singapore, pp 917–923

[Google Scholar](#)

14. Jamaludin AS, Yassin A (2013) Analysis of laser sintered materials using finite element method. Sains Malays 42(12):1727–1733

[Google Scholar](#)

15. So C, Kim YS, Park JH, Kim GY, Cha D, Ko J, Kang B (2023) Data-driven design of electrically conductive nanocomposite materials: a case study of acrylonitrile–butadiene–styrene/carbon nanotube binary composites. Adv Intell Syst 2023:200399

[Google Scholar](#)

16. Patil SJ, Pujari RB, Hou T et al (2020) Supercapacitive performance of vanadium sulfide deposited on stainless steel mesh: effect of etching. Micro and Nano Syst Lett 8:8

[Article](#) [Google Scholar](#)

17. Kalogianni DP (2021) Nanotechnology in emerging liquid biopsy applications. Nano Convergence 8:13

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