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The Influence of Thermoelectric Properties of Nanomaterial and Applications

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Abstract. To assess the thermoelectric qualities of low-dimensional materials, a nanomaterial was created. Due to its inherent nanoscale structure, a one-dimensional thermoelectric material is predicted to have superior thermoelectric characteristics and low heat conductivity. High efficiency thermoelectric energy conversion devices can be realised by taking use of these better features. Graphene and hexagonal boron nitride (h-BN), two-dimensional nanomaterials, are thermally efficient. Due to the differences in the crystal lattice and electrical structure between graphene and h-BN, a new material with novel thermal properties is created when the two join to produce a planar C-BN hybrid structure or a van der Waals heterostructure. We concentrate on these new qualities while reviewing the two new materials, as their thermal properties affect their structure, size, and number of layers. To assess the thermoelectric qualities of low-dimensional materials, a micro-instrument was created. Due to its inherent nanoscale structure, a one-dimensional thermoelectric material is predicted to have superior thermoelectric characteristics and low heat conductivity. High efficiency thermoelectric energy conversion devices can be realised by taking use of these better features. In this study, we used micromachining to create microdevices to examine the thermoelectric characteristics of low-dimensional materials. The system comprises of a tiny thermocouple with a freely suspended heating element acting as the sensing element. Manipulation was used to place an array of Bi2Te3 nanowires made using the silicon template approach on the microdevice. To show the device's ability to assess the thermoelectric properties of nanomaterials, measurements of the Bi2Te3 bundle's electrical, thermal, and Beck coefficients were made. More information about this source text source text necessary for further translation details. We offer a synthetic method for producing Cu2ZnGeSe4 nanocrystals with a limited size range and a predetermined composition. By hot pressing, these nanocrystals were employed to create nanomaterials that were tightly packed. These nanoparticles' Cu2ZnGeSe4 thermoelectric characteristics have been demonstrated to be very good. A figure of merit of up to 0.55 at 450 °C has already been achieved through early refinement of the nanocrystal composition. The performance of thermoelectric (TE) materials is currently the subject of intense research. One of the suggestions for enhancing their TE performance is nanostructuring. However, a nanomaterial's shape can have a big impact on how it behaves under tension. In this study, we showed that this action uses a microwave-assisted chemical pathway to create zinc oxide (ZnO) in two distinct forms. The molar ratios of the initial precursors were altered to create nanoparticles (NPs) and nanorods (NRs). According to the results, NRs have better TE properties than NPs, especially at higher temperatures.

Key words: Nanomaterials, Thermoelectric Material, Cu2ZnGeSe4, Bi2Te3,

1. Introduction

The most recent nanomaterials to be created are new low-dimensional materials like nanowires, nanotubes, and nanobelts because of how much interest has been drawn to their diverse features and prospective uses in nanoscale electrical, optical, and energy conversion devices. In these low-dimensional materials, heat and electron transport have both been thoroughly explored. The only interesting uses for these low-dimensional materials are thermoelectric devices for this energy conversion and energy conversion. Based on their figure of merit, some low-dimensional materials are thought to have strong thermoelectric characteristics (ZT). According to theory, low-dimensional materials should have excellent thermoelectric properties like increased power factor (electrical conductivity; see Beck coefficient) and decreased phonon thermal conductivity. Bismuth(Bi) and related alloys are particularly promising candidates for low-dimensional thermoelectric materials. All solid-state energy is converted to electricity and then transferred directly to heat in thermoelectric (TE) materials. They are viewed as one of the potential answers to the world's energy crisis and climate change. High See Beck coefficient, high electrical conductivity, and low thermal conductivity are all requirements for good thermoelectric materials. For a certain object, these parameters are not independent. Compounds based on bismuth telluride (Bi2Te3) are among the best thermoelectric materials and are frequently utilised in the medical industry. There has been a lot of study done on enhancing the TE properties of Bi2Te3 materials because of their many practical uses. The performance of microelectronic devices is significantly impacted by the thermophysical characteristics of nanomaterials. Thermoelectric (TE) devices transform thermal energy into electrical current or electrical current into waste heat. 1 The dimensionless figure of merit ZT = a2rT/j, where an is the See beck coefficient, r is the electrical conductivity, j is the thermal conductivity, and T is the absolute temperature, is used to assess the conversion efficiency of a TE material. 2 Thus, good TE materials need to have a good balance of electrical and thermal properties, but the specifics of the electronic structure influence the three factors (band). Gap, band shape, and band distortion close to the Fermi level), as well as scattering of charge carriers (electron or hole), are not independent. 3 Around room temperature, Bi2Te3 and its derivatives make excellent TE materials. 4 ZT was recently shown to be 1.47 for a bulk Bi2Te3/Sb2Te3 nanocomposite at 448 K, 1.56 for a bulk Bi0.52Sb1.48Te3 material at 300 K, and 1.56 for a bulk Bi0.52Sb1.48Te3 material. is connected to p-type alloys made of Bi2Te3, such as 7 was found for a bulk sample of nanostructured BiSbTe at 373 K. Both p- and n-type materials are required for TE applications. Bi2Te2.85Se0.15 is one of the most extensively investigated compounds for n-type Bi2Te3-based alloys. For instance, Seo et al.9 constructed atedn-type SbI3-doped Bi2Te2.85Se0.15 in the temperature range from 573 K to 713 K with a 20:1 extrusion ratio and ZT of 0.61 and 0.91 for 0 wt% and 0.05 wt% SbI3-doped were obtained, respectively. Tokiai et al.8 reported a ZT of 0.54 for Bi Bi2Te2.85Se0.15 is doped. systematic approach based on material synthesis, structural characteristics, and thermoelectric properties is necessary for the alloy Bi2Te3, which has a very high thermoelectric figure of ZT at room temperature and a large number of structural and chemical degrees of freedom that affect thermoelectric properties. theory. For nanomaterials with low dimensionality1, an increase in ZT has been predicted; it has also been demonstrated for Bi2Te3/Sb2Te3 superlattices. Since this development, a significant area of research has focused on the creation of Bi2Te3-based nanowires, 3-6 thin films, 7–10, and nanostructured materials, 11–14. Relating to thermoelectric materials. The study package reported here includes thermoelectric characterization of nanostructured aggregates, thin films, and nanowires as well as advanced materials production methods. Advanced X-ray, electron, and spectroscopic approaches have been used to characterise the nanostructure and catalysts. Partial band structure, excitation, and transport features are discussed in the cluster theory. The cluster's objectives are to create and regulate synthesis processes for Bi2Te3 nanomaterials, assess how dimension and nanostructure affect thermoelectric properties, and create a plan for reaching high ZT in Bi2Te3-based nanomaterials. The cluster's objective is to combine synthesis, structure, kinetics, thermoelectric characterization, and theory/modeling to create a roadmap for Bi2Te3 nanomaterials that will enable them to attain a ZT that is much more than 1. The various work sets in the cluster were joined to do this.

2. Thermoelectric

The thermoelectric properties are observed to increase with a delta-shaped transport distribution. This finding suggests that for maximal thermoelectric efficiency, a narrow distribution of electron energy is needed during the transport phase. Generators and freezers can both be made using thermoelectric materials. These solid state devices are not very dependable because they have moving elements. They are utilised in products where reliability is more critical than performance because of their poor performance. To find cold electronic components like infrared sensors or computer chips, thermoelectric refrigerators are employed. Satellites and space stations both employ power generators. Much work has gone into developing better thermoelectric materials. Numerous thermoelectric material systems have been created and previously examined. Our objective is to present a summary and recent developments in thermoelectric materials. Single-phase aggregates come first. The chem., cyst structure, physical qualities, and thermoelectric performance are given special consideration. The object class is used to order these systems. Second, the composite materials with aggregate nanostructures will be examined. With our current understanding of the category of objects, the prospects for increased performance in nanostructured materials will be examined. The guest atoms are essentially regarded to "rattle" in these cages, and the scattering lattice phonons prevent the lattice from conducting heat. The "silent" atoms are significant, but the open structure also has a negative impact on thermal conductivity. The synthesis and characteristics of this family of chemicals have recently been reviewed in depth. The thermoelectric properties are observed to increase with a delta-shaped transport distribution. This finding suggests that for maximal thermoelectric efficiency, a narrow distribution of electron energy is needed during the transport phase. Generators and freezers can both be made using thermoelectric materials. These solid state devices are not very dependable because they have moving elements. They are utilised in products where reliability is more critical than performance because of their poor performance. To find cold electronic components like infrared sensors or computer chips, thermoelectric refrigerators are employed. Satellites and space stations both employ power generators. Much work has gone into developing better thermoelectric materials.

3. Microstructure

According to their free energy equilibrium NsM and NsM, materials with nanometer-scale microstructures can be categorised, and NsM that is out of thermodynamic equilibrium is referred to as "non-equilibrium" NsM. The size of non-equilibrium NsM structural components—mostly crystalline—materials is a few nanometers (at least in one direction). In other words, non-equilibrium NsM has boundary regions that divide its nanoscale-scale building pieces, making it fundamentally heterogeneous at the nanometer scale. Varied varieties of non-equilibrium NsM are characterised by their constituent parts (e.g., crystals with different or similar chemical compositions, atomic structures, shapes, sizes, etc.). There are other microstructural characteristics that distinguish various NsM outside the size, structure, etc. of the building blocks. In actuality, the areas at their boundaries are comparable beds. They have an impact. The boundary areas' atomic structure, chemical makeup, thickness, and other characteristics all have an impact on how NsM behaves. In other words, even if the fundamental components, such as two crystals of NsM, have equivalent sizes and chemical compositions, their characteristics may differ dramatically if their interfacial structures are different. Let's start by thinking about the non-polymeric NsM. Non-polymeric NsMs can be classified based on their chemical makeup, the boundary regions of their microstructural components, and the shape (dimension) of the crystals. These materials have nanometer-sized crystals and interfaces. Three different varieties of NsM may be identified based on the crystal structure: layered crystals, wire-shaped crystals (with layer thickness or wire diameter on the order of a few nanometers), and NSM made up of crystals with uniform nanometer sizes. The four families of NsM can be subdivided into the three types of NsM based on the chemical makeup of the crystals. All crystals and interfaces have the same chemical makeup in the most straightforward scenario. Semi-crystalline polymers are an example of this family of NsM, which is made up of stacked crystalline lamellae separated by non-crystalline regions. The second family of NsM is built of crystals with similar nanometer-sized dimensions, such as copper (third type). The most well-known examples of this kind are probably crystals, which come in a variety of chemical compositions. Quantum wells (multilayer) structures are another. The type of chemical bonding forces and the characteristics of the boundaries in NsM are predicted to affect the atomic structures of the boundary areas. In materials having directional bonds (like Si and C), the struggle between the local structural disorder at the border and the variation created by the hybridization of the bonds in the region of the interfaces greatly influences the structure of the boundary.

4. Nanomaterial

Nanocrystalline materials have grains or particles that are up to 100 nm in size. These substances have improved mechanical, magnetic, optical, high-temperature, and catalytic properties. The successful incorporation of these materials into aggregates that shield nanostructures is the key to commercial uses of nanocomposites outside of materials science laboratories. Due to the issue of grain expansion, traditional consolidation procedures are severely limited in their ability to sustain nano grain size. Metal-based nanomaterials have been created in a novel way via the extrusion technique. ceramic matrix composite powders. Today, hydrostatic extrusion is also used to process such materials to attain homogeneous mechanical properties throughout. It can be regarded of as an extension of hot pressing. The discharge temperature is chosen based on the substance that will be synthesised. The extruded material is often a ceramic, metal, or composite, and the extrusion rate and temperature are set. parameters for loaded extrusion tests with various materials. Carbon nanotubes (CNT), one of the constituents in the table, ought to be present in alloy systems. Ceramics that have been strengthened with metal. It should be highlighted that compared to other systems, Al-based systems have higher discharge rates. Al has more slip structures than other crystal structures, which explains this. For allotropic materials, phase transition assisted synthesis can be effective and affordable. For the synthesis of nanomaterials, not much high-tech infrastructure is needed. The method does not produce stable crystal formations, though.

5. Conclusions

To assess the thermoelectric qualities of low-dimensional materials, a micrometre was created. The system consists of a freestanding heating element and an integrated transient sensing element made of microthermocouples. This microthermocouple aids in measuring the heater's end temperature. measurements of the constructed Bi2Te3 bundle's I-V properties, Seebeck voltage, and heat transport. This model connects several sensor components. This work looked into the TE characteristics of ZnO nanostructures made chemically with microwave assistance. This demonstrates that the produced NRs displayed some TE features that were superior to NPs. ZnO NRs greatly outperformed NPs in terms of electrical conductivity and Seebeck coefficient at higher temperatures. The enhanced electron mean free path and decreased interfacial barriers may be to blame for this. Additionally, NRs showed much less heat conductivity. By successfully scattering phonons on their surface, NRs are observed to correlate to the new idea of phonon glass-electron crystal materials. The results of this investigation showed that morphology is significant and that NRs are very advantageous for the formation of TE force. The higher output power of NRs suggests that they are superior than NPs for usage in TE devices. By pairing appropriate p-type pairs with large-sized ZnO NRs pairs (n-type), the generated power can be increased. Briefly, spark plasma sintering combined with hydrothermal synthesis is used to create bulk nanostructured graphene/Pi2Te3 composites. Bi2Te3 particles were coated with graphene nanosheets in precursor nanopowders, with grain sizes ranging from 30 to 200 nm. This study examines the impact of graphene component content on the thermoelectric characteristics of aggregates with nanostructures.

References

[1]. Wang, Jingang, Xijiao Mu, and Mengtao Sun. "The thermal, electrical and thermoelectric properties of graphene nanomaterials." *Nanomaterials* 9, no. 2 (2019): 218.

[2]. Ono, Takahito, Chia-cheng Fan, and Masayoshi Esashi. "Micro instrumentation for characterizing thermoelectric properties of nanomaterials." *Journal of Micromechanics and Microengineering* 15, no. 1 (2004): 1.

[3]. Ibáñez, Maria, Reza Zamani, Aaron LaLonde, Doris Cadavid, Wenhua Li, Alexey Shavel, Jordi Arbiol et al. "Cu2ZnGeSe4 nanocrystals: synthesis and thermoelectric properties." *Journal of the American Chemical Society* 134, no. 9 (2012): 4060-4063.

[4]. Farooqui, Nafees Akhter, Amit Kumar Mishra, and Ritika Mehra. "Concatenated deep features with modified LSTM for enhanced crop disease classification." *International Journal of Intelligent Robotics and Applications* (2022): 1-25.

[5]. Baghdadi, Neazar, Numan Salah, Ahmed Alshahrie, A. R. Ansari, and Kunihito Koumoto. "The effect of morphological modification on the thermoelectric properties of ZnO nanomaterials." *Ceramics International* 47, no. 5 (2021): 6169-6178.

[6]. Singh, Anuja, Tapan Behl, Aayush Sehgal, Sukhbir Singh, Neelam Sharma, Tanveer Naved, Saurabh Bhatia et al. "Mechanistic insights into the role of b cells in rheumatoid arthritis." International Immunopharmacology 99 (2021): 108078.

[7]. Kumar, Ashish, Nilanjana Banerjee, Venugopal Singamaneni, Sudheer K Dokuparthi, Tulika Chakrabarti, and Sibabrata Mukhopadhyay. "Phytochemical investigations and evaluation of antimutagenic activity of the alcoholic extract of Glycosmis pentaphylla and Tabernaemontana coronaria by Ames test." Natural Product Research 32, no. 5 (2018): 582-587.

[8]. Liang, Beibei, Zijun Song, Minghui Wang, Lianjun Wang, and Wan Jiang. "Fabrication and thermoelectric properties of graphene/composite materials." *Journal of Nanomaterials* 2013 (2013).

[9]. Krishna Kumar TP, D R Pallavi, M. Ramachandran, Chandrasekar Raja, "Evaluation of Techno-economic Using Decision Making Trial and Evaluation Laboratory (DEMATEL) Method", Recent Trends in Management and Commerce, 3(2), (2022):101-110.

[10]. Wang, Jingang, Xijiao Mu, Xinxin Wang, Nan Wang, Fengcai Ma, Wenjie Liang, and Mengtao Sun. "The thermal and thermoelectric properties of in-plane C-BN hybrid structures and graphene/h-BN van der Waals heterostructures." *Materials Today Physics* 5 (2018): 29-57.

[11]. Mishra, Amit Kumar, and Shweta Paliwal. "Mitigating cyber threats through integration of feature selection and stacking ensemble learning: the LGBM and random forest intrusion detection perspective." *Cluster Computing* (2022): 1-12.

[12]. Khan, Zuhaib Ashfaq, Hafiz Husnain Raza Sherazi, Mubashir Ali, Muhammad Ali Imran, Ikram Ur Rehman, and Prasun Chakrabarti. "Designing a wind energy harvester for connected vehicles in green cities." Energies 14, no. 17 (2021): 5408.

[13]. Ranjit, P. S., and Venkateswarlu Chintala. "Direct utilization of preheated deep fried oil in an indirect injection compression ignition engine with waste heat recovery framework." *Energy* 242 (2022): 122910.

[14]. Mansour, Romany F., Eatedal Alabdulkreem, Heba F. Eid, K. Sathishkumar, Mohd Abdul Rahim Khan, and Anil Kumar. "Fuzzy logic based on-line fault detection and classification method of substation equipment based on convolutional probabilistic neural network with discrete wavelet transform and fuzzy interference." Optik 270 (2022): 169956.

[15]. Kumawat, Gaurav, Santosh Kumar Vishwakarma, Prasun Chakrabarti, Pankaj Chittora, Tulika Chakrabarti, and Jerry Chun-Wei Lin. "Prognosis of Cervical Cancer Disease by Applying Machine Learning Techniques." Journal of Circuits, Systems and Computers 32, no. 01 (2023): 2350019.

[16]. Du, Y., K. F. Cai, H. Li, and B. J. An. "The Influence of Sintering Temperature on the Microstructure and Thermoelectric Properties of n-Type Bi2Te3− x Se x Nanomaterials." *Journal of electronic materials* 40, no. 5 (2011): 518-522.

[17]. Krishna Kumar TP, Vimala Saravanan, M. Ramachandran, Manjula Selvam, "A Market Segmentation Assessment Weighted Scoring for Using WSM Method An Study for Different Market", REST Journal on Banking, Accounting and Business, 1(3), (2022):1-8

[18]. Ibáñez, Maria, Reza Zamani, Stéphane Gorsse, Jiandong Fan, Silvia Ortega, Doris Cadavid, Joan Ramon Morante, Jordi Arbiol, and Andreu Cabot. "Core–shell nanoparticles as building blocks for the bottom-up production of functional nanocomposites: PbTe–PbS thermoelectric properties." *ACS nano* 7, no. 3 (2013): 2573-2586.

[19]. Kumar, Ashish, Somenath Roy Chowdhury, Tulika Chakrabarti, Hemanta K. Majumdar, Tarun Jha, and Sibabrata Mukhopadhyay. "A new ellagic acid glycoside and DNA topoisomerase IB inhibitory activity of saponins from Putranjiva roxburghii." Natural Product Communications 9, no. 5 (2014): 1934578X1400900523.

[20]. Farooqui, Nafees Akhter, Amit Kumar Mishra, and Ritika Mehra. "Automatic crop disease recognition by improved abnormality segmentation along with heuristic-based concatenated deep learning model." *Intelligent Decision Technologies* Preprint (2022): 1-23.

[21]. Bajaj, Karan, Bhisham Sharma, and Raman Singh. "Implementation analysis of IoT-based offloading frameworks on cloud/edge computing for sensor generated big data." Complex & Intelligent Systems 8, no. 5 (2022): 3641-3658.

[22]. Mahesh, G. Sreeramulu, V. G. T. Rakesh, S. B. Mohan, and P. S. Ranjit. "Energy management with blockchain technology in DC microgrids." *Materials Today: Proceedings* 47 (2021): 2232-2236.

[23]. Soni, Rajkumar, Prasun Chakrabarti, Zbigniew Leonowicz, Michał Jasiński, Krzysztof Wieczorek, and Vadim Bolshev. "Estimation of life cycle of distribution transformer in context to furan content formation, pollution index, and dielectric strength." IEEE Access 9 (2021): 37456-37465.

[24]. Bhalla, Kanika, Deepika Koundal, Bhisham Sharma, Yu-Chen Hu, and Atef Zaguia. "A fuzzy convolutional neural network for enhancing multi-focus image fusion." Journal of Visual Communication and Image Representation 84 (2022): 103485.

[25]. Karupusamy, Sathishkumar, Mohammed Ahmed Mustafa, Bos Mathew Jos, Priyanka Dahiya, Ramakant Bhardwaj, Pratik Kanani, and Anil Kumar. "Torque control-based induction motor speed control using Anticipating Power Impulse Technique." The International Journal of Advanced Manufacturing Technology (2023): 1-9.

[26]. Mukherjee, Tulika, Tapas Sarkar, Piyali Paul, Ajit K. Chakraborty, Parasuraman Jaisankar, and Siba Brata Mukhopadhyay. "Putralone, a novel 10α-hydroxy-25-nor D: A friedo-oleanane triterpenoid from Putranjiva roxburghii." Natural Product Communications 7, no. 4 (2012): 1934578X1200700424.

[27]. Tian, Yuan, Mohammed R. Sakr, Jesse M. Kinder, Dong Liang, Michael J. MacDonald, Richard LJ Qiu, Hong-Jun Gao, and Xuan PA Gao. "One-dimensional quantum confinement effect modulated thermoelectric properties in InAs nanowires." *Nano letters* 12, no. 12 (2012): 6492-6497.

[28]. Krishna Kumar TP, M. Ramachandran, Sathiyaraj Chinnasamy, Malarvizhi Mani, “Matrix Organization Analysis Using Grey Relational Analysis”, REST Journal on Banking, Accounting and Business, 1(1), (2022):64-71

[29]. Aabdin, Zainul, N. Peranio, O. Eibl, W. Töllner, K. Nielsch, D. Bessas, R. P. Hermann et al. "Nanostructure, excitations, and thermoelectric properties of Bi2Te3-based nanomaterials." *Journal of electronic materials* 41, no. 6 (2012): 1792-1798.

[30]. Rathor, Ketan, Keyur Patil, Mandiga Sahasra Sai Tarun, Shashwat Nikam, Devanshi Patel, and Sasanapuri Ranjit. "A Novel and Efficient Method to Detect the Face Coverings to Ensurethe Safety using Comparison Analysis." In 2022 International Conference on Edge Computing and Applications (ICECAA), pp. 1664-1667. IEEE, 2022.

[31]. Nautiyal, Aditi, and Amit Kumar Mishra. "Machine learning approach for intelligent prediction of petroleum upstream stuck pipe challenge in oil and gas industry." *Environment, Development and Sustainability* (2022): 1-27.

[32]. Ranjit, P. S., and M. Saxena. "Prospects of hydrogen utilization in compression ignition engines-A review." International Journal of Scientific Research (IJSR) 2, no. 2 (2013): 137-140.

[33]. Garg, Sheetal, Raman Singh, Mohammad S. Obaidat, Vinod Kumar Bhalla, and Bhisham Sharma. "Statistical vertical reduction-based data abridging technique for big network traffic dataset." International Journal of Communication Systems 33, no. 4 (2020): e4249.

[34]. Sukumaran, C., and P. J. Sebastian. "Effect of Inclusive Games and Physical Exercises on Selected Physical Variables among the Intellectually Challenged Children." Annals of the Romanian Society for Cell Biology 26, no. 01 (2022): 1442-1450.

[35]. Hati, Ananda Shankar, Prasun Chakrabarti, Jemal H. Abawajy, and Ng Wee Keong. "Development of energy efficient drive for ventilation system using recurrent neural network." Neural Computing and Applications 33, no. 14 (2021): 8659-8668.

[36]. Zhang, Peng, Yukun Li, Yongshang Zhang, Ruohan Hou, Xilai Zhang, Chao Xue, Shaobin Wang, Bicheng Zhu, Neng Li, and Guosheng Shao. "Photogenerated electron transfer process in heterojunctions: in situ irradiation XPS." *Small Methods* 4, no. 9 (2020): 2000214.

[37]. Krishna Kumar TP, M. Ramachandran, Chandrasekar Raja, Ashwini Murugan, “Understanding of E-Learning Programs using WPM MCDM Method”, REST Journal on Banking, Accounting and Business, 1(2), (2022):13-19

[38]. Gleiter, Herbert. "Nanostructured materials: basic concepts and microstructure." *Acta materialia* 48, no. 1 (2000): 1-29.

[39]. Rathor, Ketan, Sushant Lenka, Kartik A. Pandya, B. S. Gokulakrishna, Susheel Sriram Ananthan, and Zoheib Tufail Khan. "A Detailed View on industrial Safety and Health Analytics using Machine Learning Hybrid Ensemble Techniques." In 2022 International Conference on Edge Computing and Applications (ICECAA), pp. 1166-1169. IEEE, 2022.

[40]. Sukumaran, C., D. Selvam, M. Sankar, V. Parthiban, and C. Sugumar. "Application of Artificial Intelligence and Machine Learning to Predict Basketball Match Outcomes: A Systematic Review." Computer Integrated Manufacturing Systems 28, no. 11 (2022): 998-1009.

[41]. Koundal, Deepika, and Bhisham Sharma. "Advanced neutrosophic set-based ultrasound image analysis." In Neutrosophic set in medical image analysis, pp. 51-73. Academic Press, 2019.

[42]. Viswanathan, Venkatachalapathy, T. Laha, Kantesh Balani, Arvind Agarwal, and S. Seal. "Challenges and advances in nanocomposite processing techniques." *Materials Science and Engineering: R: Reports* 54, no. 5-6 (2006): 121-285.

[43]. TP, Krishna Kumar, and M. Ramachandran. "Using a ELECTRE MCDM method for Software Testing Techniques."

[44]. Beecroft, Laura L., and Christopher K. Ober. "Nanocomposite materials for optical applications." *Chemistry of materials* 9, no. 6 (1997): 1302-1317.

[45]. Farooqui, Nafees Akhter, and Ritika Amit Kumar Mishra. "Analysis of Antioxidant and Rutin Content in Buckwheat Flour Bread by Machine Learning Approach." *Design Engineering* (2021): 17188-17201.

[46]. Ranjit, P. S., and M. Saxena. "State-of-the-art of storage and handling issues related to high pressure gaseous hydrogen to make use in internal combustion engines." International Journal of Scientific & Engineering Research (IJSER) 3, no. 9 (2012): 1-17.

[47]. Sukumaran, C., and P. J. Sebastian. "Effect of Inclusive Games and Physical Exercises on Selected Physical Variables among the Intellectually Challenged Children." Annals of the Romanian Society for Cell Biology 26, no. 01 (2022): 1442-1450.

[48]. Rathor, Ketan, Anshul Mandawat, Kartik A. Pandya, Bhanu Teja, Falak Khan, and Zoheib Tufail Khan. "Management of Shipment Content using Novel Practices of Supply Chain Management and Big Data Analytics." In 2022 International Conference on Augmented Intelligence and Sustainable Systems (ICAISS), pp. 884-887. IEEE, 2022.

[49]. Ishida, Hatsuo, Sandi Campbell, and John Blackwell. "General approach to nanocomposite preparation." *Chemistry of Materials* 12, no. 5 (2000): 1260-1267.

