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Analysis the Mechanical Property of Wild Palm Tree Fiber Reinforced Composite Material

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Abstract: ***Due to the numerous benefits of polymer matrix composites (PMCs), the replacement of conservative materials such as wood, metals, and ceramics has been taking place at a very fast rate. This fast progress in the use of PMCs has also raised severe problems such as plastic pollution, shortage of landfills, high energy consumption, and depletion of petroleum resources. Furthermore, plastic pollution is harmful to the health of humans over and above land and marine animals. Because of all these issues, investigators are concentrating in the direction of the production of greener materials. The use of natural fibers for the reinforcement of plastics is a noble tactic in the direction of the solution of all these problems. Nevertheless, the strength and performance of synthetic fibers can't equal that of natural fibers on the other hand some cellulosic fibers like flax, hemp, jute, sisal, caraua, and coir have been examined and found as potential replacements for other ceramic and/or synthetic fibers. Numerous investigators have testified their work on the development and characterization of natural fiber composites in addition to finding their applications for moderate strength applications. Furthermore, natural fiber composites have compensations such as high specific strength, lighter, cheap, waste utilization, and the source of employment in rural areas. However, unsuitability between the hydrophilic natural fibers and hydrophobic polymers is a main problem in the case of natural fiber composites, which can be overcome by physical and chemical treatment of fibers.***

Keywords: Polymer Matrix Composites (PMC), Natural Fiber Composites (NFC), Life Cycle Assessments (LCA), Sustainability, Biodegradability, Wild date Palm tree.

I. INTRODUCTION

In composites, the materials are combined on a macroscopic scale, allowing them to make better use of their strengths while minimizing to some extent the effects of imperfections. This optimization process relieves designers of the limitations associated with traditional material selection and fabrication. You can use stronger and lighter materials with properties that can be adjusted to meet your specific design needs. Because even complex shapes can be easily manufactured, a complete rethinking of established designs from a composites perspective often leads to better and more cost-effective solutions.

The properties that can be improved by forming components are:

1) Strength
2) Stiffness
3) Corrosion resistance
4) Wear resistance
5) Biodegradability
6) Attractiveness
7) Weight
8) Fatigue life
9) Temperature-dependent behavior
10) Thermal insulation
11) Thermal conductivity
12) Acoustical insulation

Not all of the above symptoms can be improved at the same time, but many of them can be improved. Composites have been around for a long time. The Israelites used straw to strengthen mud bricks. Fiber-reinforced plastic composites have a high stiffness-to-weight ratio. This is why composites are so popular in aircraft and spacecraft. These materials are also frequently used in the automotive industry for weight-sensitive functions.

A. *Nano-composites*

Composites with a reinforcement size ranging from 0.1 to 100nanometers are called nano-composites and can use reinforcement in the form of nanotubes, nano fibers, or nanoparticles. Very great potential lies in the production of strong and wear-resistant metal matrix nano- composites by liquid and powder processing. Due to their several favorable properties, nanoparticles are currently replacing micro fillers as reinforcing materials in polymer matrix composites. The nano-fillers act as a bridge between the matrix and the fiber. An ultrasonic bath is used to uniformly disperse the nanoparticles with polyester resin. Some common nanoparticles are silicon dioxide (SiO2), alumina (Al2O3), titanium dioxide (TiO2), graphite, etc. Among them, silica nanoparticles have proven to be one of the best nano fillers to improve the mechanical performance of polyester composites due to their high specific strength low density, and cost-effectiveness. In our study, we have used nano silica (SiO2) as reinforcement in the polyester resin.

II. LITERATURE REVIEW

Naheed Saba et.al. represented knowledge about the varied classes of natural fibres, nano filler, cellulosic fibre based composite, nano composite, and natural fibre / nano filler-based hybrid composite where by specifying their application as well. Incorporation of nano particles in place of reinforcement of composite showed higher properties.

Ashish Thakur et.al. have done an attempt to prepare a completely new composite material with Bamboo fibre reinforced in the epoxy resin, varying percentage of CNT and examining the mechanical characteristics of the prepared composite specimens. Thecomposite samples were prepared and their grain size and grain boundary was analysed using Atomic Force Microscope (AFM). Tests like Tensile, Flexural and Impact Strength of the Bamboo fibre & CNT reinforced polymer composites were studied by conducting tests on the INSTRON-3382 machine at CIPET, Bhopal, Madhya Pradesh. Hybrid composites of bamboo + epoxy dispersed with 1%, 2%, and 3% CNT have been successfully prepared using hand lay-up technique. Tensile strength of the specimens increased with increasing % of CNT in hybrid composite. Material became brittle with increasing % of CNT in epoxy + bamboo specimen. Increment in the number of grains and average grain size were also observed.

Ashish Kumar et.al. have done an study to enhance the mechanical properties of natural fibre composite mixed with glass fibre. Sisal fibre was mixed with glass fibre reinforces epoxy composites. Hand lay- up method was used. Tests like Tensile, flexural & impact test were performed on the specimens. This paper concluded the upgradation of the mechanical properties to larger extent along with increasing the moisture resisting capacity. Tensile strength of epoxy failed to improve by the reinforcing of sisal fibre while tensile modulus, flexural properties and impact properties were found to be improved.

Sofiene Helaili et.al. did fabrication of Alfa Fibre (composite material). Matrix – EpoxyResin, Reinforcement – natural Alfa fibre. Moulding technique is used to judge the structural application. Here, flexural modulus increased in a linear way as fibre content increases. When we compare epoxies modulus of elasticity, we can conclude that Alfa Fibre gave superior stiffness to the composite and moreover better elongation before failure was observed.

Dan M.Constant in escu et. al. mixed pure epoxy with the nano silica particles. Bothun-functionalized and functionalized nano silica particles were added into pure epoxy. The three different Wt% of nano silica was added are 0.1, 0.3 and 0.5 Wt%. They cannot obtain a conclusive remark from the monotonic static testing and tensile testing at the room temperature which lead to the enhancement of mechanical properties. For the enhancement of the mechanical characteristic, sonication method was used in which fumed silica is mixed. As a result, smaller clusters are formed by gradually breaking up of larger aggregates.

III. METHODOLOGY

A. *Equipment's Required*

The machine and pieces of equipment required for the fabrication of polymer hybrid composite are listed below:

1) Weighing machine
2) Borosil glass beakers
3) Magnetic stirrer
4) Ultrasonic bath
5) Mechanical stirrer
6) Mild steel plate die
7) Mild steel shoulder die
8) Nano silica particles in powdered form
9) Polyester resins
10) Wild date palm fiber in the form of woven mat
11) Hardener

Work Plan

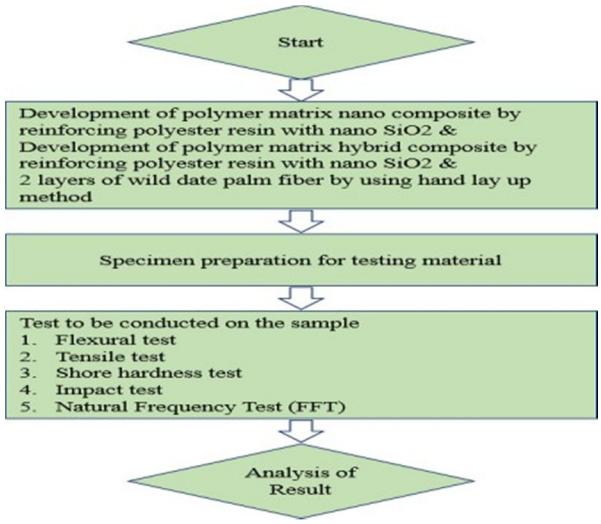


Figure: 1 Work plan

IV. RESULTS AND DISCCUSION

A. Tensile Test Observations

Following graphs below depicts the load vs. extension plots of various composition variations as well as orientations. It could be seen clearly over here is each and every change in wt% of SiO2 as well as orientation of fiber leads to comprehensive changes in ultimate load as well as extension.

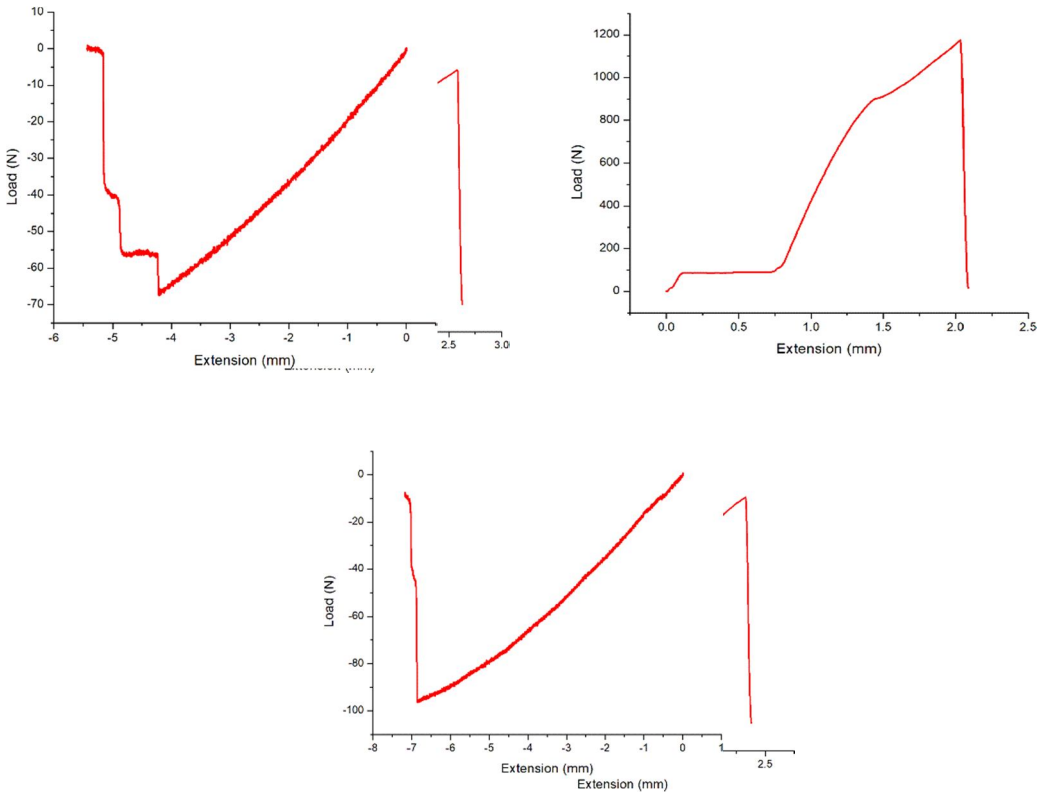


Figure 2: Load variation with extension at individual composition and variation

B. Flexural Strength Variation with Composition

Following graphs below depicts the flexural load vs extension plots of various composition variations as well as orientations. It could be seen clearly over here is each and every change in wt% of SiO_2 as well as orientation of fiber leads to comprehensive changes in ultimate load as well as extension.

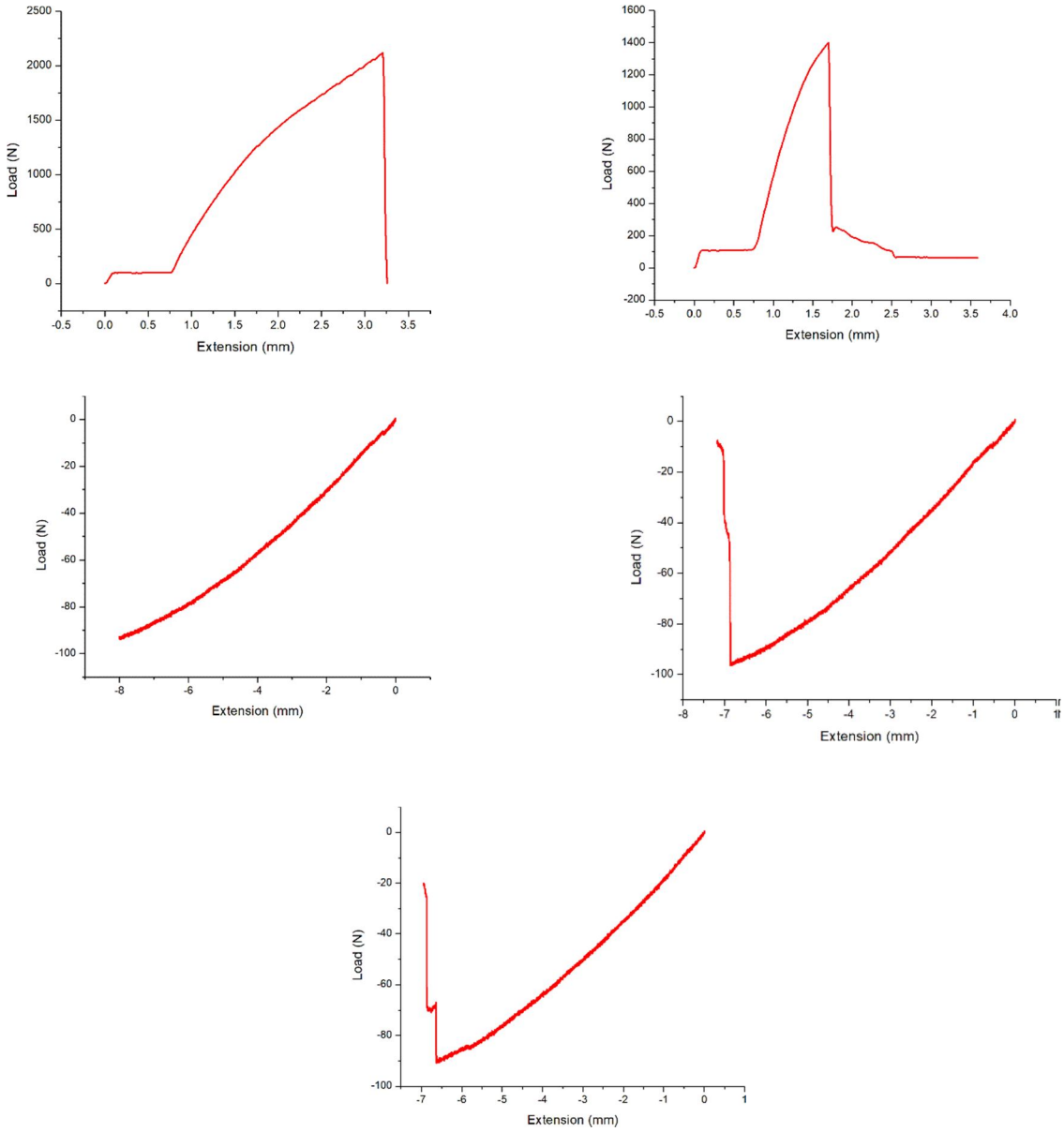


Figure:3 Flexural Test Load v/s elongation curves

V. CONCLUSION

In the present study, wild date palm fiber reinforced polyester composite or green composites were successfully developed and their mechanical properties were tested. The following conclusions can be drawn from the results obtained:

1) A new class of polymer composites that use Wild Date Palm natural Fiber as fillers.
2) The tensile, flexural and impact strength of the composite were enhanced by a two-layer wild date palm fiber(WDPF)reinforced hybrid polyester resin composite with nano SiO_2 particles.
3) Sonication with an ultrasonic bath uniformly disperse the nano silica particles in the polyester resin.
4) From the Izod impact tests, it can be concluded that the impact resistance increases until the nano silica content in the hybrid polymer matrix composite reaches 2 wt% and then gradually decreases.

5) Tensile tests results shows that the tensile strength increased up to 2 wt% nano silica in the hybrid polymer matrix composite and gradually decreased.

6) The flexural tests results shows that the flexural strength increases until the nano-silica content in the hybrid polymer matrix composite reaches 2% by weight and then gradually decreases.

REFERENCES

[1] M.R. Mansor, M.T. Mastura, S.M. Sapuan, A.Z. Zainudin Available online21 September 2018, Version of Record 21 September2018.Woodhead Publishing Series in Composites Science and Engineering201 9, Pages 257-285.

[2] Markets and market. Natural fiber composites market by type (wood fiber and non-Wood fiber),manufacturing process(compression, injection molding and others), application and construction, automotive industry, electrical and electronic products factory)and region, Global Forec astto2021.

[3] Vikas S. Hoysala, Kiran Kumar, T. Madhusudhan,Static and dynamic behavior of juterein forced epoxy composite with and without silicon dioxide modifier, Int. Res. J. Eng.Technol.(IRJET)02(2)(2015)480– 484.

[4] Hosseini, S. B., S. Hedjazi, L. Jamalirad, and A. Sukhtesaraie. 2014. Influence of nano-SiO2 on the physical and mechanical properties of fiber reinforced composite materials(FRC). Indian Academic Journal of Wood Sciences 11 (2): 116-121. Doi: 10.1007/s13196-014-0126-y.

[5] Ashori, A. (2008). Wood-plastic composites as promising green composites for The automotive industry.Biological Source Technology,99,4661-4667.10.1016/j.biortech.2007.09.043.

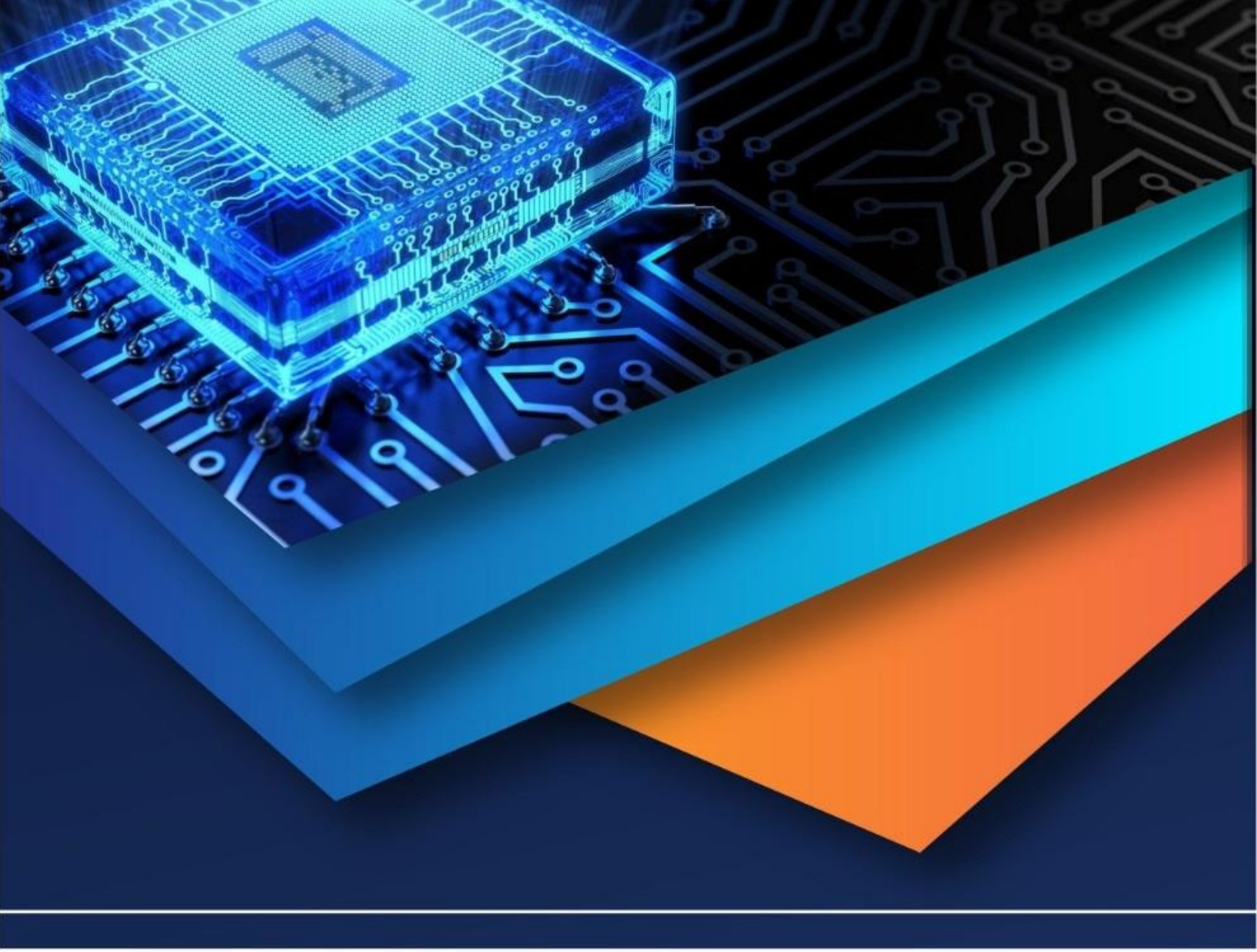
[6] J. Lin, B Zhong, Z Jia, D Hu, Y Luo, D Jia , Applied Surface Science 407 (2017) 130–136.

[7] S.J. Park, J.S. Jin, Effect of silane coupling agent on interphase and performance of glass fibers/unsaturated polyester composites, J. Colloid. Interface. Sci. 242(2001) 174–179.

[8] F. Ansari, M. Skrifvars, L. Berglund, Nanostructured biocomposites based on unsaturated polyester resin and a cellulose nano fiber network, Compos. Sci.Technol. 117 (2015) 298–306.

[9] Emrique v. Barrera , “Key methods for developing single-wall nanotube composites”, Composites Overview, 52, 38-42, 2000.

[10] Shofner ML, Corral EL ,“Carbon nanotubes: science and applications” , Boca Raton, 2004, https://doi.org/10.1201/9780203494936.



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