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Fabrication and Analysis of Brake Pad using Natural Fiber Reinforced Composite

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***Abstract:** Brakes have been advanced in the recent years through many developments. Previously all these years brake pads were made of asbestos fiber which are very harmful in many ways. When vehicles apply brake, the asbestos gets wear down and releases asbestos dust into the ambience and surrounding. This asbestos dust also gets entrapped inside the brake housing which is also a vital problem to be considered. Hence when there is requirement to open the brake housing, the asbestos dust is released into the air and the workers may accidentally inhale it without consciousness. It also posed a risk during manufacturing in industries as the workers are exposed to asbestos risk when they knowingly or unknowingly come into contact with asbestos. Thus a new development is introduced with certain natural fibers such as calotropis and napier along with additives such as epoxy resin and hardener. All these fibersare used to make brake pad material which posses certain properties and the results of various analysis done have been obtained to make a good use for manufacturing brake pads in the upcoming future.*
***Keywords:** calotropis gigantea, napier, epoxy resin*

I. INTRODUCTION

A composite is formed by the combination of two materials. One material is in the form of particles, fibers or sheets called the reinforcing phase and the other is called the matrix phase onto which the reinforced phase is embedded. All these combinations of the matrix phase and the reinforced phase can be made into a polymer, metal or ceramic. Generallyfibers are the main load carrying members in the composites which have a particle phase which is more stiffer and stronger in relation to continuous matrix phase.

The fiber composites are classified to their types accordingly as natural fibers and synthetic fibers. The natural fibers are considered for many applications due to their features of bio- degradability, cheap, renewable and partial recyclability. The natural fibers are used as an alternative to glass, manmade fibers due to their well defined properties and are more environmental friendly where they are used for many application such as building industries, transportation etc. They are usually obtained from various mineral sources, animals as well as plants. They have been used in the automotive industry to make the parts more environment sustainable.

The composites industry has begun to recognize that the commercial applications of composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus the shift of composite applications from aircraft to other commercial uses has become prominent in recent years. Increasingly enabled by the introduction of newer polymer resin matrix materials and high performance reinforcement fibers of glass, carbon and aramid, the penetration of these advanced materials has witnessed a steady expansion in uses and volume. The increased volume has resulted in an expected reduction in costs. High performance FRP can now be found in such diverse applications as composite armoring designed to resist explosive impacts, fuel cylinders for natural gas vehicles, windmill blades, industrial drive shafts, support beams of highway bridges and even paper making rollers. For certain applications, the use of composites rather than metals has in fact resulted in savings of both cost and weight. Some examples are cascades for engines, curved fairing and fillets, replacements for welded metallic parts, cylinders, tubes, ducts, blade containment bands etc.

Further, the need of composite for lighter construction materials and more seismic resistant structures has placed high emphasis on the use of new and advanced materials that not only decreases dead weight but also absorbs the shock & vibration through tailored microstructures. Composites are now extensively being used for rehabilitation strengthening of pre-existing structures that have to be retrofitted to make them seismic resistant, or to repair damage caused by seismic activity. Unlike conventional materials (e.g., steel), the properties of the composite material can be designed considering the structural aspects.

A composite material consists of two or more physically and or chemically distinct, suitably arranged or distributed phases, with an interface separating them. It has characteristics that are not depicted by any of the components in isolation. Most commonly, composite materials have a bulk phase, which is continuous, called the matrix, and one dispersed, non-continuous, phase called the reinforcement, which is usually harder and stronger.

II. LITERATURE SURVEY

Enjuan Cao, et al (1) has studied a facile polymerization of m-phenylenediamine (mPD) in methanol/water was performed via conventional chemical oxidative method by using Calotropisgigantea fiber (CGF) as the natural biotemplate. Among the most frequently detected antibiotics, ciprofloxacin (Cip) has attracted increasing attention as the second generation of fluoroquinolone antibiotics for treating bacterial infections. With Calotropisgigantea fiber as the bio-template, a series of hollow-tubular-oriented adsorbents were successfully prepared in a mixture with the equal volume of methanol and water by using mPD as the monomer.

Chainman Kumar Dashin, et (2) has developed karyotypic features of these two species were studied with orcein staining and banding with two base specific fluorochromes such as chromomycine A3 (CMA) and 4´, 6 diamidino-2-phenylindole (DAPI) for authentic cytogenetical characterization. Gi-ganteais used for the treatment of various diseases.*Gigantea*are used as poultice against rheumatism, chest pain due to cold, paralyzed parts and in dropsy.The karyotype profile of these two species with extended karyomorphological features could enrich the chromo-somal database of medicinal plants of Bangladesh and create a baseline for the future research and conservation management policies.

Seare T. Desta, et al (3) has designed ensiling characteristics, structural and nonstructural carbohydrate composition and enzymatic digestibility (ED) of Napier grass silage was examined. Napier grass (Pennisetum purpureum.), a monocot grass belongs to Poaceae family and Pennisetum genus, is widely distributed throughout tropical and subtropical regions. All additives increase the sugar and decreased lignocellulosic content of Napier grass silage compared to control. Higher reduction in lignocellu-losic and reserve in sugar was recorded in fibrolytic enzyme and formic acid silage respectively.

MuhammadImranDin, et al (4) has studied Nickel (Ni) and nickel oxide (NiO) nanoparticles (NPs) were successfully synthesized by using a simple, novel and green synthetic route using metal salt and leaves extract of a wild plant “Calotropisgigantea” which act as reducing as well as stabilizing agent due to extra availability of phenolic contents and antioxidants in it. Nanotechnology has been acquired marvelous impetus in this rapidly emerging technological era by creating a wealth of scientific ideas to compete with daily challenges of growing technology. We emphasized on the impetus of Green synthesis of Ni and NiO NPs by using Calotropisgigantea plant extract but we also proved that further green routes can be adopted to synthesize Ni and NiO NPs by using Urea, Starch and various other plant extracts .

WenzhenDuan, et al (5) has developed fluoroquinolone antibiotics (FQs) have been detected frequently in aquatic environment with the concentration level of up to mg/L.Among different kinds of an-tibiotics, fluoroquinolone antibiotics (FQs) have been demonstrated with broader antibacterial spectra, and shown effective inhibition on Gram-positive bacteria, Gram-negative bacteria and anaerobes. With NaClO2-treated Calotropisgiganteafiber as the bio-template, a sustainable adsorbent material was designed by a facile oxidative polymerization using pyrrole as the monomer and FeCl3 as a trigger.

Muhammad Rowshanul Habib, et al (6) has designed test the insecticidal activity of ethyl acetate extract ofCalotropisgiganteaL. flower (designated as EECF) against stored grain pest Triboliumcastaneum (Herbst) of different larval and adult stages. Most of the chemicals that are used as insecticides in agricultural sector for crop protection, have undesirable effects on living beings particularly animals and human.Residual film method was used here to study the toxicity ofEECFagainstTriboliumcastaneum and gas chromatography-mass spectrometer analysis was also performed tocharacterize the chemicals of EECF.

Renugadevi K, et al (7)] has studied new attempt has been made in the manufacturing of helical springs, using CalotropisGiganteafibre as the raw material. CalotropisGigantea (CG) is a tropical shrub plant with high seasonality and naturally high yield. Composites are among the most versatile, high-performance materials that enable a combination of optimum mechanical and thermal properties that cannot be achieved using a single phase materialThis work reports a plausible replacement to the artificial glass fibre compression spring using a CalotropisGigantea (CG) fibre reinforced spring.

PattanopKanokratana, et al (8) has developed Energy grass is a promising substrate for production of biogas by anaerobic digestion. However, the conversion efficiency is limited by the enzymatically recalcitrant nature of cellulosic wastes. The global energy industry is undergoing a rapid transition from its dependence on the non renewable fossil resource to more sus-tainable carbon-neutral resources. The microbial community structure and gene profiles of an Np-LMC constructed for degradation of Napier grass, a potent energy crop, have been characterized in this study.

Irfan Newaz Khan, et al (9) has designed evaluate possible anxiogenic activity, sedative property and anxiolytic potential of crude ethanolic extract of Calotropisgigantea leaves. Currently herbal drugs are wide-spoken as green medicine for their safe and dependable health care paradigms.: T he obtained results provide support for the use of this species in traditional medicine and warrant further investigation to isolate the specific components that are responsible for the sedative and anxiolytic effects.

PipatLounglawan, et al (10) has studied harvested plant material was weighed, dried and the ground subsamples taken for analyses of crude protein (CP), crude fiber (CF), ash, ether extract (EE), acid detergent fiber (ADF), neutral detergent fiber (NDF), acid

detergent lignin (ADL), Hemicellulose and Cellulose. The nutritive value of grass for cattle depends upon the amount of dry matter consumed, the chemical composition and the coefficient of digestibility of the dry matter. The chemical composition has been shown to vary with the stage of maturity, soil conditions and climate. The present study clearly shows that cutting interval has a marked effect on the dry matter yield and nutrient composition of King Napier grass.

TibebuManaye, et al (11) in this paper present, has reviewed the A role of computer vision in fruits and vegetables among various horticulture products of agriculture fields. In his paper, we examine the paper broadly related to fruits and vegetables among various.

Wazha Mugabe, et al (12) has designed study aimed to investigate the effects of hexanoic acid (Hex),Lactobacillus plantarum (Lp) and their combination on the fermentation profile of Napier grass (Pennisetum purpureum) silage.Ensiling is a traditional technique for the conservation of wet crops in the livestock industry and an important method for preserving biomass before its anaerobic digestion.Lactobacillus plantarumimproved fermentation quality as indicated by greater LA and lower pH as compared to the C and Hexcontaining silages.

MurugesanBalaji, et al (13) has studied fabrication of green fluorescent reduced graphene oxide quantum dots (GOQDs) from the latex of Calotropisgigantea by simple one-step microwave assisted greener route. Quantum dots (QDs) are nanoscale semiconductor particles, due to its nano size the optical and electronic properties of the QDs differ from their larger particles. At the end of this work, we have successfully prepared the stable and economically sustainable GOQDs from the latex of Calotropisgi-gantea by on step microwave assisted greener method.

MupenziMutimura,et al (14) has developed was planned to analyse the basis that make Brachiaria species with greater feeding value than Napier grass (Pennisetum purpureum) for lactating dairy cows. It is a multi-purpose grass for feed with land sparing because it produces high biomass on small size of the land. Piata (Piata grass) than those based on Napier grass (P. purpureum) were most likely due to the better chemical composition of Piata grass compared with that of Napier grass.

RuethaiNarinthorn, et al (15) has designed Alkaline and biological pretreatments were compared for enhancing the biological methane potential of Napier grass. The earlier reported biotreatments for Napier grass did not use the edible white-rot fungus Pleurotussajor-caju, as in the present work.Biogas, a mixture of methane and carbon dioxide, produced by anaerobic digestion of renewable organic matter such as lignocellulosic biomass may be used to generate electricity and steam, or employed as a transport fuel.A 2-day treatment of the coarse cut dried Napier grass with dilute alkali (20 cm^3 of NaOH removed nearly 47% of the lignin while the loss of cellulose was kept to < 3.5%.

Khang D.H. Nguyen,et al (16) has developed new lignan, 9^0-methoxypinoresinol , and two new glycosylated 5-hydroxymethylfurfurals, calofurfuralside A , and calofurfuralside B , together with nine known compounds have been isolated from the active fractions, $CHCl_3$ and EtOAc fractions of the leaves of Calotropisgigantea also used in tradi-tional folk medicines for the treatment of bronchitis, dyspepsia, paralysis, swellings and intermittent fevers. Three new compounds, 9^0-methoxypinoresinol, calofurfuralside A and calofurfuralsideB , were isolated along with the nine known compounds from the leaves of C. Gigantea.

SupawadeeParhira, et al (17) has studied aimed to isolate bioactive cardenolides from C. gigantea, to screen their hypoxia-inducible factor (HIF-) 1 inhibitory activity, and to analyze the structure-activity relationship. It has been tradition-ally used for the treatment of anthelmentic, leprosy, asthma, diabetes mellitus, rheumatoid arthritis, neurodermatitis, syphilis and cancers in folk Chinese or Ayurvedic medicine. gigantea as inhibitors of HIF-1 transcriptional activity. It may provide guidance for the rational drug design of cardenolide-based HIF-1 inhibitors for the development of anticancer drug.

ParipokPhitsuwan,et al (18) has designed treatment protected carbohydrates in the fibre and greatly reduced lignin content , resulting in the deconstruction of the fibrous matrix. Because of the declining reservoirs of petroleum/fossil fuel, using renewable and non-food lignocellulosic materials from agricultural-by-products, forest residues, food wastes, and energy crops as an alternative source of energy is an important research focus. Aqueous ammonia treatment at room temperature for 14 days selectively removed lignin from NP fibre, giving a 58.7% reduction of lignin content while retaining carbohydrates; this was also confirmed by FTIR.

ParipokPhitsuwan,et al (19) has developed to delignify lignocellulose with the aim of improving glucose recovery from Napier grass stem cellulose via enzymatic saccharification. Declining petroleum resources and higher demand for energy due to increased industrialisation and motorisation have led to attempts to identify alternative energy sources. This superior outcome was due to the extensive removal of lignin , which created porosity and allowed the accessibility of cellulose to cellulases.

K. Obi Reddy,et al (20) has studied effect of alkali-treatment on the thermal degradation, tensile properties and surface changes of Napier grass fibers was investigated in this work.Natural fibers/fabrics, wood and agro-based waste materials mainly consist of α-cellulose, hemi cellulose and lignin as compo-nents with complicated structures.The thermal stability, crystallinity and tensile

properties of Napier grass fibers before and after alkali-treatments were studied. Thesepropertieswere found to increase in alkali-treatment.

YOUSEF ALOHA.et.al(21) has developed NaOH solutions and the effect of alkali treatment on the composition and structure of the fibers was studied. Alkali treatment eliminated the amorphous hemicellulose component of the fibers to a larger extent. Concern for the environment, rising oil prices, and the finite na-ture of oil reserves is driving research into ways to replace petro-chemical products with biobased materials. The composition of the native fibers was determined by chemical analysis, which indicated the presence of α-cellulose, hemicellulose, and lignin in them.

M.J.M. Ridzuan,et al (22) has designed effects of soaking time during the alkaline treatment on the tensile strength of Napier grass fibre and its morphology are discussed. “Napier grass” (Pennisetumpurpureum) is a plant with an interesting source of fibres which originally from Brazil. Tremendous progresses have been made in recent years in the development of materials from agricultural crops based fibres. The tensile properties of the untreated and treated Napier grass fibre with 10% NaOH aqueous solutions were investigated. The 6 and 24 hr soaking time during treatment yield the highest strength.

S.Srikarthikeyan,et al (23) has developed brakes have been advanced in the recent years through many developments. Previously all these years brake pads were made of asbestos fiber which are very harmful in many ways. A composite is formed by the combination of two materials. One material is in the form of particles, fibers or sheets called the reinforcing phase and the other is called the matrix phase onto which the reinforced phase is embedded. , it can be observed from the various analysis results conducted on asbestos brake pad and the natural fibres brake pad that the natural fibresare good enough and used as a brake pad material for an automobile brake system.

III. SPECIFICATION OF DIFFERENT COMPONENTS

A. Calotropis Gegantea Fiber

Calotropisbast fiber is one of these types that have been extracted manually up to now. Some research article investigates the effect of new decorticator machine on properties of extracted fiber and compared with separated fibers manually.

The mentioned decorticator machine was able to extract bast fiber without shattering stems and flowing latex. Some studied properties were morphological characterization, tensile properties (tensile strength, Young’s modulus and strain) and density of fiber.Calotropis stem has valuable fibers with various applications in the industry.

Since extraction found to be more complex, extraction machine with the capacity of based on dried mass of barks and fibers was developed. Calotropis gigentea fruit fiber reinforced composites was prepared and mechanically tested. The tensile strength increased with increase in fiber content.

B. Napier Fiber

Napier grass fibre to assess the effect of alkaline treatment on the tensile properties, thermal stability, and morphology of the fibres. These fibres were extracted by a water retting process from the internodes of Napier stems. Napier grass fibre to assess the effect of alkaline treatment on the tensile properties, thermal stability, and morphology of the fibres.These fibres were extracted by a water retting process from the internodes of Napier stems.

IV. EXPERIMENTAL SETUP

A. Wear Test

The brake pads are an important component in the braking system of vehicles. Materials used for brake pads should have high durability, stabile and reliable frictional and wear properties under varying conditions of load, velocity, temperature and environment. In this regard, has been produced an organic frictional material with coconut fibre, friction modifiers, abrasive materials and solid lubrificant using powder metallurgy. In this paper are presented the experimental determinations carried out under laboratory conditions for testing the friction material developed. In this sense will be analysed density, porosity, hardness, mechanical properties, the evolution of the friction coefficient and the temperature field in the contact area between the disc and the brake pad on an own design installation. The results performed in the laboratory give a better image about the performance of the developed friction material recipes designed to make the brake pads for small and medium vehicles.

For laboratory testing of organic composite materials used for brake pad applications, an experimental installation was developed and it was presented . The results obtained allow the evaluation of the behaviour of organic friction material. The installation consists of the following components: electric motor with power of 2.2 kW and speed of 2950 rpm, gearbox, belt drive, vacuum pump with membrane, planetary shaft, hub, pivot, brake disk. Vacuum pump training is carried out by a trapezoidal belt transmission.

B. Shore D Hardness Test

Shore D Hardness is a standardized test consisting in measuring the depth of penetration of a specific indenter. Test methods used to measure Shore D Hardness are ASTM D2240 and ISO 868.

The hardness value is determined by the penetration of the Durometer indenter foot into the sample. Shore Hardness measures are dimensionless. It goes between 0 and 100. The higher number represents the harder material.

The resulting depth is dependent on:

1) Hardness of the material
2) Its viscoelasticity
3) Shape of the indenter
4) Duration of the test.

C. Impact Test

The Charpy impact test, also known as the Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's notchtoughness.

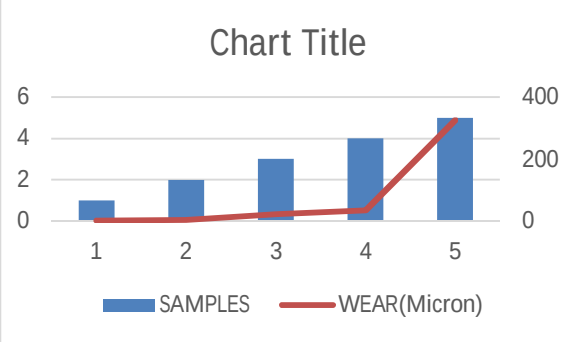
Acts as a tool to study temperature-dependent ductile-brittle transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply. A disadvantage is that some results are only comparative.

V. RESULT

As per the Felix Swamidoss v and Prasanth true analys the experimental procedure and its result where the Napier and Calotropis Gegantea brake pad is compared with the pineapple brake pad with varius characteristics.

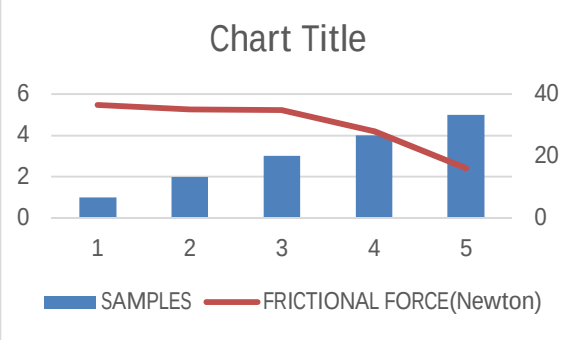
A. WEAR(Micron)

This is a result of proper bonding between the Napier and Calotropis fiber and epoxy resin as the percentage of fiber decreases and also inter packing distance. In hardness testing it can be figured out that when the percentage of Napier and Calotropis fiber decreases the hardness value of the sample increases.



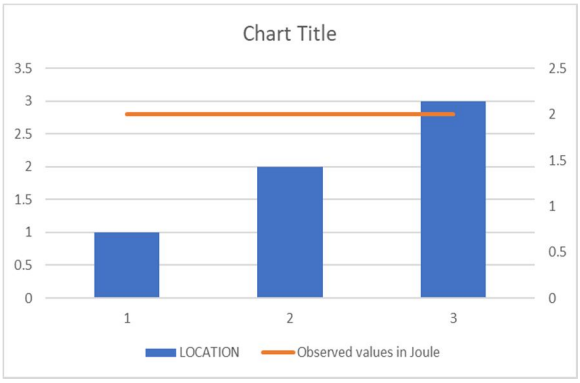
B. Frictional Force(Newton)

The sample with decrease of pineapple leaf fiber has the highest hardness value of 101.6HBN. The high hardness for is because due to the result of lower fiber content in it. The hardness value decrease for this percentage is compared with other material.



C. Impact Test (Joule)

The result to higher packaging which affects stronger binding of napier and calotropis fiber. This is also due to high hardness value, compressive strength and the sample size. The water absorption rate depends upon the swelling of the sample.



VI. CONCLUSION

Through the results discussed it can be observed from the various analysis results conducted on asbestos brake pad and the natural fibres brake pad that the natural fibres are good enough to be functioned and used as a brake pad material for an automobile brake system. The results from finite element analysis shows that calotropis and napier fibre brake pad has the highest deformation, and stresses and strains besides the asbestos brake pad which has a much lesser deformation and stresses and strains in comparison to calotropis and napier fibre brake pad.

But since the asbestos brake pad leads to asbestos exposure risk which is harmful for life, we are forced to go to an alternative and consider the natural fibre brake pads. Even though calotropis and napier fibre brake pad has higher rate in comparison to asbestos brake pad, the features of the natural fibre makes us ignore the results of the higher rates of deformation, stresses and strains due to the primary properties of the natural fibres. Among the other fibers, the fibre with least deformation is the jute fibre.

It also has the stresses and strains much lower in comparison to other fibres and asbestos. So it is preferable for automotive industries to use jute fibre as the brake pad material. Even though it is expensive, it serves good in terms of long life and the primary features of environment friendliness.

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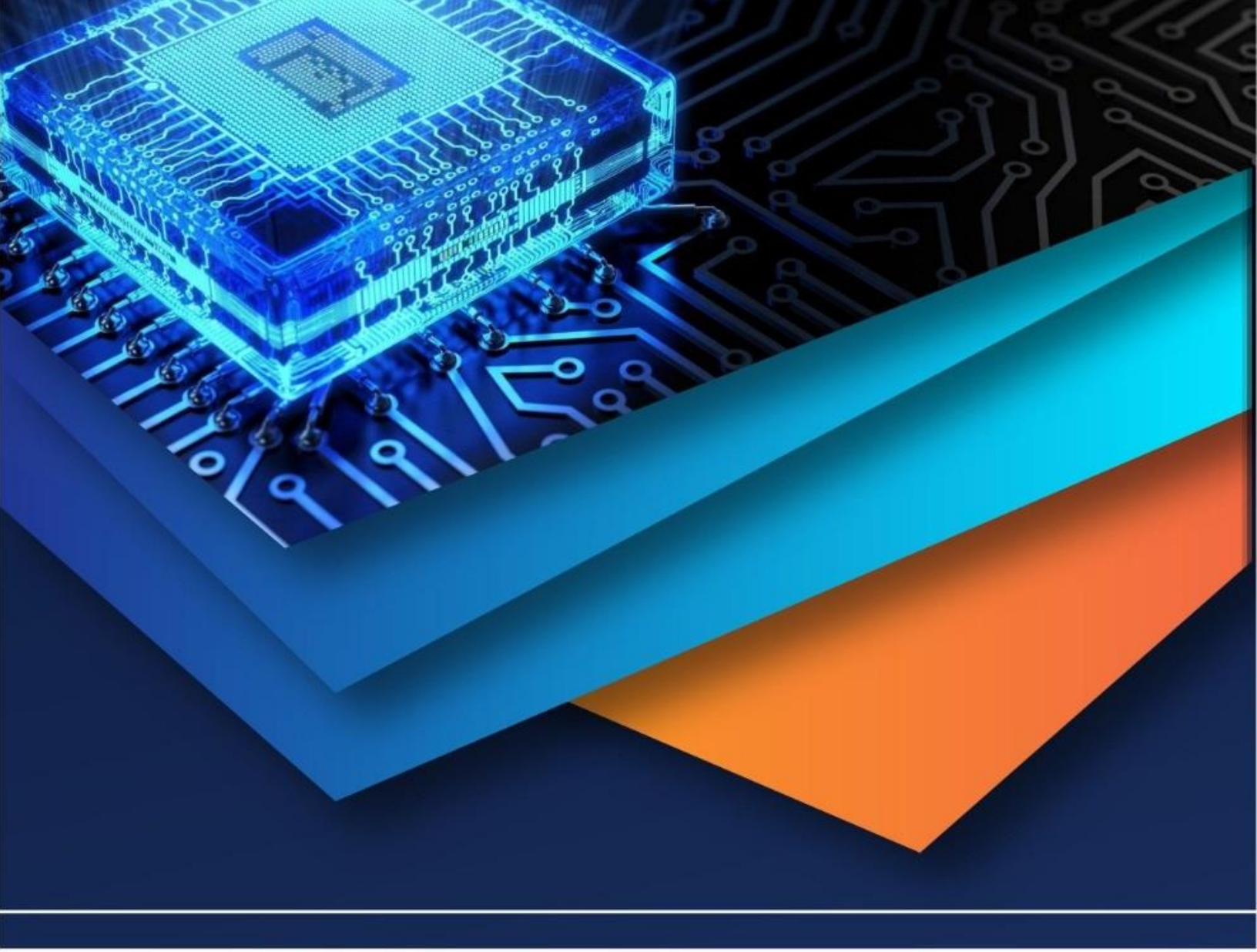

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