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Study and Analyze of Wear Behavior Carbon Nano Tube-Epoxy Resin Composite Material

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Abstract: Composite materials are the answer to most of mankind's engineering needs. They offer better structural and mechanical properties than any conventional materials like metals, alloys, plastics and polymers. They offer better characteristics than any of their individual constituent materials. This project aims to study and analyze the carbon nanotube-epoxy resin composite material, where the matrix is formed by epoxy resin, reinforced by carbon nanotubes. We subject such specimens to wear tests to understand their action in real-life applications, and try to improve upon their already superior properties by further reinforcing this material with fiber, and backing up our findings with observations.
Keywords: Carbon nano tubes, epoxy composites, friction temperature, wear composite materials

I. INTRODUCTION

Improved interfacial adhesion between carbon nanotubes and the polymer results in nano composites exhibiting improved wear rates compared to ultrahigh-molecular-weight polyethylene alone. Polymer nano composites represent a new alternative to conventionally filled polymers. Because of their nanometer sizes, filler dispersion nano composites exhibit markedly improved properties when compared to the pure polymers or their traditional composites. In comparison with other commercial polymers, ultrahigh-molecular weight polyethylene (UHMWPE) possesses superior mechanical properties, such as low density, high impact strength, and high wear resistance. Consequently, UHMWPE is widely used as a wear-resistant material in gears, seals, and bearings. These include increased modulus and strength, outstanding barrier properties, improved solvent and heat resistance and decreased flammability. Polymer fiber reinforced composite material have very good desirable properties such as low density, high specific stiffness, high specific strength, a controlled coefficient of thermal expansion and dimension stability. The adding of carbon nano particle in these composites will improve the properties of the material. The wear properties also improved, which pave the way for more applications of these composites.

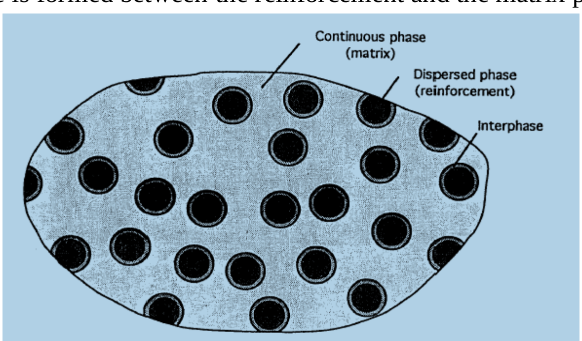
II. COMPOSITES

A. Definition

A composite is a material system consisting of two or more phases on a macroscopic scale, whose mechanical performance and properties are designed to be superior to those of the constituent materials acting independently.

B. Constituents Of A Composite Material

The structure of composite materials is made up of two phases. One of these phases is usually stronger and stiffer than the other, and forms the discontinuous phase, and is called the reinforcement phase. The other phase, by comparison, is less stiff and has lower structural strength. This is known as the matrix phase. Sometimes, due to chemical interactions between these two phases, an intermediate phase known as interphase is formed between the reinforcement and the matrix phases.



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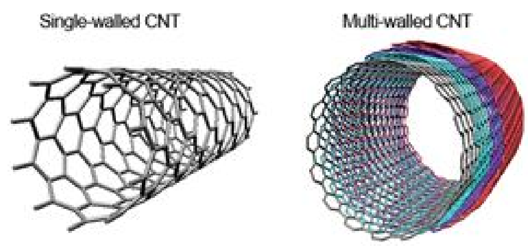
1) *Matrix Phase:*The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it. Polymers, metals, ceramics also, continuous phase, surrounds other phase. (Metal, ceramic or polymer).
2) *Reinforcementphase:* Reinforcing constituents in composites, as the word indicates, provide the strength that makes the composite what it is. But they also serve certain additional purposes of heat resistance or conduction, resistance to corrosion and provide rigidity. Reinforcement can be made to perform all or one of these functions as per the requirements. A reinforcement that embellishes the matrix strength must be stronger and stiffer than the matrix and capable of changing failure mechanism to the advantage of the composite. This means that the ductility should be minimum or even nil the composite must behave as brittle as possible.

III. COMPONENTS

A. Components Used

1) *Carbon NanoTube*



Single-walled carbon nanotubes and multi-walled carbon nanotubes are similar in certain respects but they also have striking differences. SWNTs are an allotrope of sp^2 hybridized carbon similar to fullerenes. The structure is a cylindrical tube including six-membered carbon rings similar to graphite. Analogously MWNTs include several tubes in concentric cylinders.

2) *Epoxy resin*

Epoxy resins are polyether resins containing more than one epoxy group capable of being converted into the thermoset form. These resins, on curing, do not create volatile products in spite of the presence of a volatile solvent. The epoxies may be named as oxides, such as ethylene oxides (epoxy ethane), or 1,2-epoxide. The epoxy group also known as oxidant contains an oxygen atom bonded with two carbon atoms.

3) *Hardener:* Hardener is a substance mixed with paint or other protective covering to make the finish harder or more durable. It ia curing agent fore
4) *Poxies*

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5) *Machines Used*
6) Scanning Electron Microscope

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7) Edax (Energy dispersive X-ray)
8) Pin on disc machine

IV. EPOXIDATION

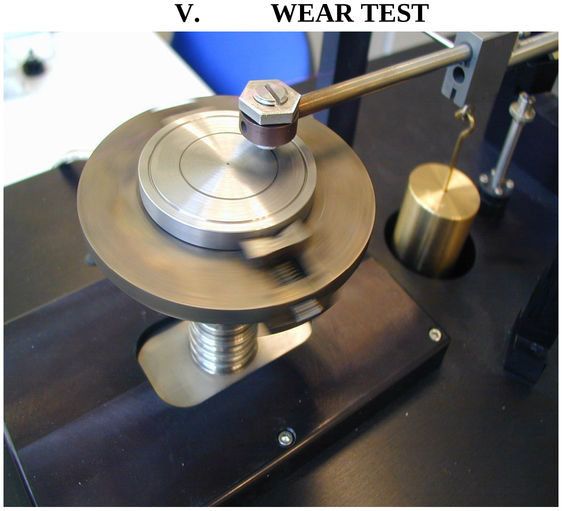
There are three important methods of producing epoxides. First is catalytic epoxidation. Here the oxidation of olefins is carried out by directly oxidizing them in the vapor phase in the presence of a catalyst such as silver. Second is epoxidation by organic peroxides and their esters. Unsaturated compounds such as hydrocarbon fatty acids and their esters are epoxidized by peroxyacetic acid. 19 Third is epoxidation by inorganic peroxides andi inorganic peroxy-acids. Sodium peroxide or tungsten acid deposited on a inert surface is used for the epoxidationofolefins by hydrogen peroxide.

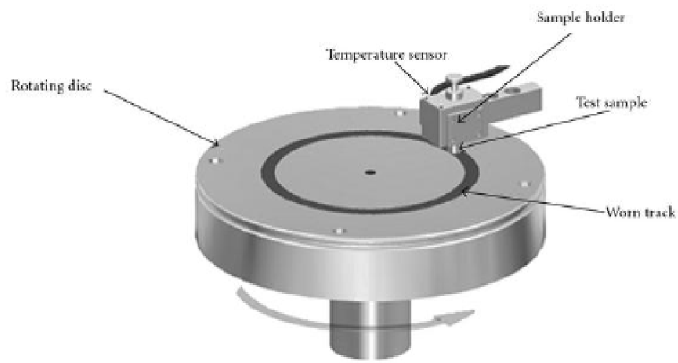
A. Major types of epoxy resins

1) Solid epoxy resins

2) Liquid epoxy resins

V. WEAR TEST





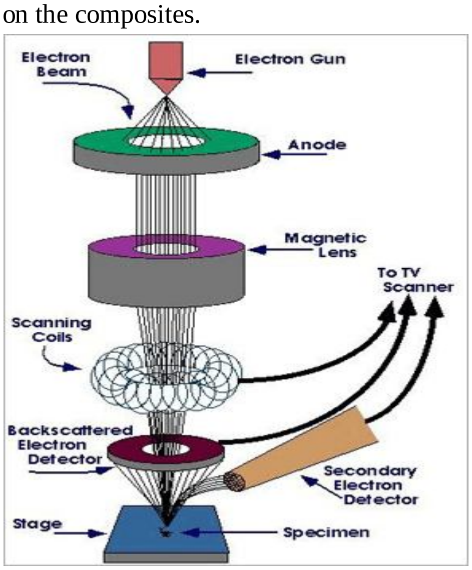
The Falex ISC-200PC Tribometeruses pin-on-disk system to measure wear. The unit consists of a gimbaled arm to which the pin is attached, a fixture which accommodates disks up to 2, 75" in diameter, an electronic force gauge for measuring the friction force, and a unique computer chart recorder for displaying, printing, or storing data for analysis. Included with the Falex ISC-200PC is a weight set capable of applying contacts stresses up to 2GPa. The motor driven turntable produces up to180 rpm. Wear is quantified by measuring the wear groove with a profilometer and measuring the amount of material removed. Wear tests were carried out on all specimens for uniform sliding speed of 100 rpm, and incremental distances. The weight lost due to wear was calculated, and results tabulated.

VI. RESULT FOR FIBRE CASTING AND RESIN CASTING POLYMERS

SLIDING SPEED (rpm)	LOAD(kg	SLIDING DISTAN	SPECIMEN	FORCE (N)	WEIGHT BEFORE WEAR	WEIGHT AFTER WEAR(g)	WEAR (mm^3)
100	3	100	1%	12.88	6.23	6.21	-41.35
100	3	200	3%	13.05	6.50	6.49	60.02
100	3	300	5%	13.75	6.53	6.52	79.01

VII. SEM IMAGING

Scanning Electron Microscope (SEM) imaging is done to view the composites on a microscopic level, and observe the effects of the wear test on the composites.



SLIDING SPEED (rpm)	LOAD(kg)	SLIDING DISTANC	SPECIMEN	FORCE (N)	WEIGHT BEFORE WEAR	WEIGHT AFTER WEAR(g)	WEAR (mm^3)
100	3	100	1%	11.07	8.83	8.83	-64.32
100	3	200	3%	20.50	8.97	8.97	-6.02
100	3	300	5%	30.11	9.04	9.04	0.02

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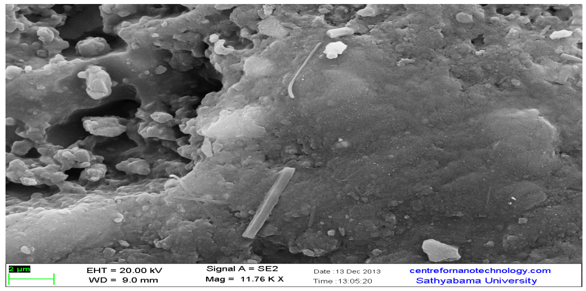
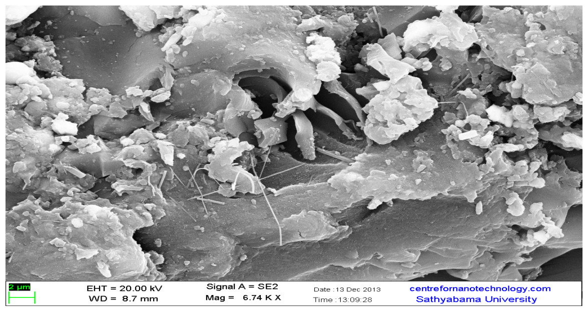
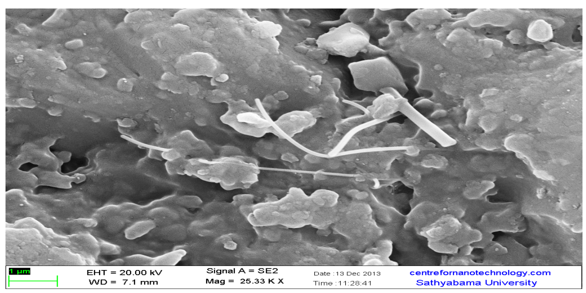
The images obtained by the SEM imaging areshown below



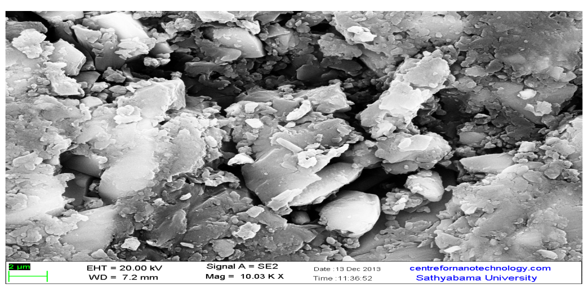
Microstructure of resin casting (CNT 1%)
@ magnification 11.76 K X



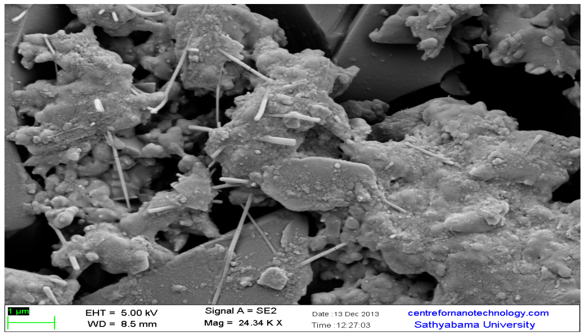
Microstructures of resin casting (CNT 3%)
@ magnification 6.74 K X



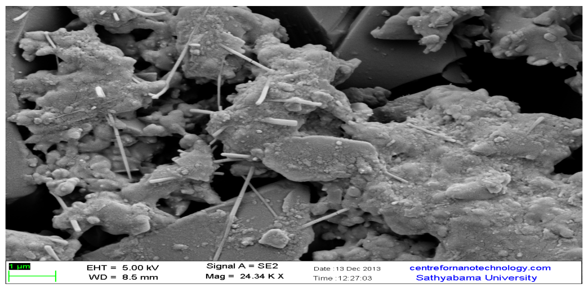
Microstructure of resin casting (CNT 5%)
@ magnification 25.33 K X



Microstructures of hand pultrusion casting
(fibre+ CNT 3%)
@ magnification 5.24 K X

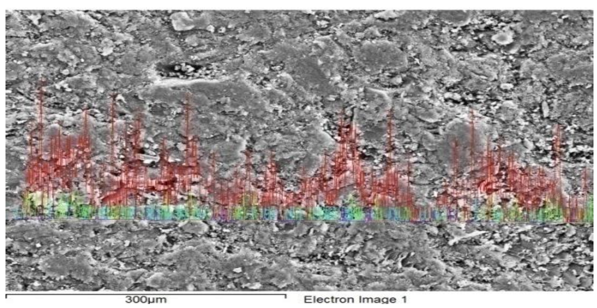


Microstructure of hand pultrusioncasting
(fibre+ CNT 1%)
@ magnification 10.03 K X

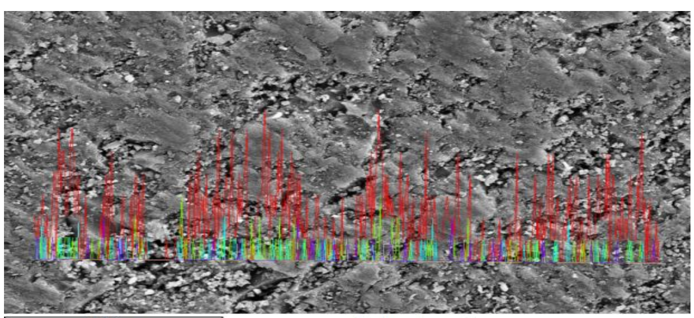


Microstructure of hand pultrusioncasting
(fibre+ CNT 5%)
@ magnification 24.34 K X

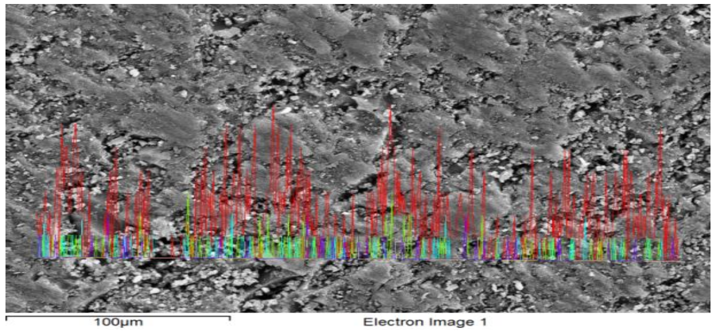
VIII. EDAX REPORTSDAX TEST IS CARRIED OUT ON THE SPECIMENS, AND THE RESULTS OBSERVED.



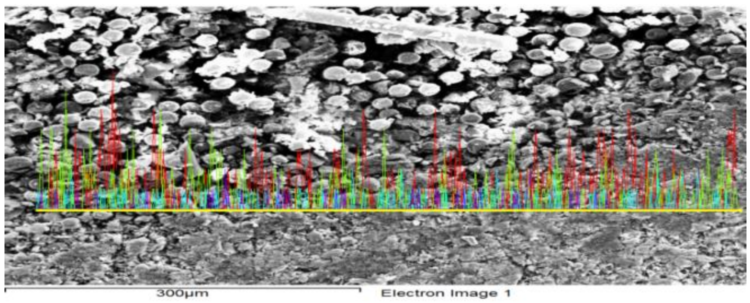
CNT RESIN CASTING 1%



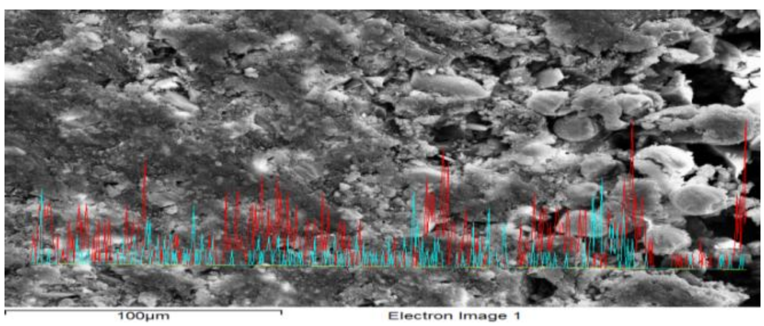
CNT RESIN CASTING 3%



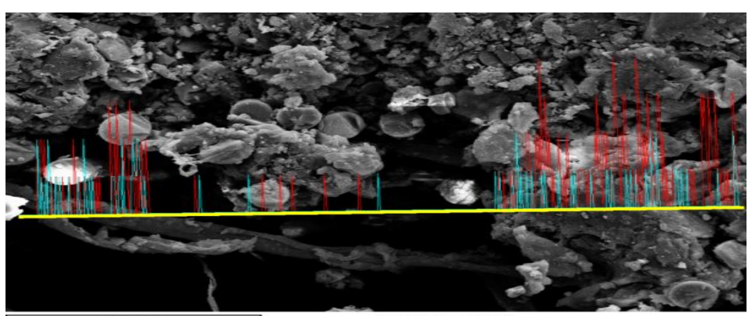
CNT RESIN CASTING 5%



FIBRE CASTING 1%



FIBRE CASTING 3%



FIBRE CASTING 5%

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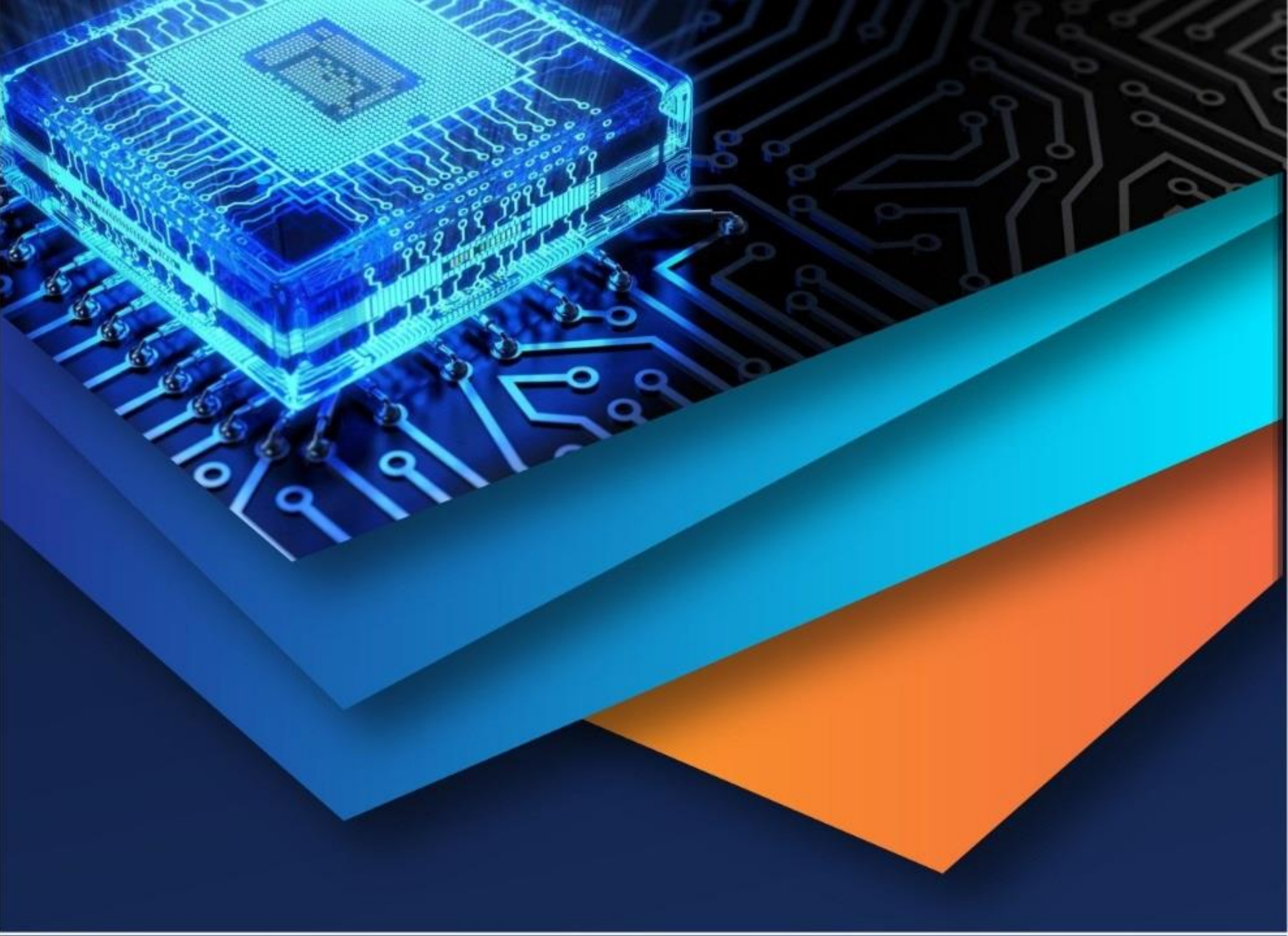

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