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Green Synthesis of ZnO Nanoparticles Using Leaves of Trachyspermum Ammi and Citrus Aurantifolia

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Abstract: The titled compound has been synthesized by using leaves of Trachyspermum ammi (Ajwain), Citrus aurantifolia (Lime) and nanoparticles of ZnO was synthesis .The UV –Visible Spectra of Aqueous extract of Trachyspermum ammi and Citrus aurantifolia was taken. XRD pattern of Hexagonal Trachyspermum ammi and Citrus aurantifolia was studied.
Keywords: Nanoparticles, ZnO, Synthesis, Trachyspermum ammi (Ajwain), Citrus aurantifolia (Lime)

I. INTRODUCTION

Nanotechnology is the science, engineering, and technology conducted at the Nano scale, which is about 1 to 100 nanometers. Nano science and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, material science, and engineering. The ideas and concepts behind nano science and nanotechnology started with a talk entitled “There’s Plenty of Room at the Bottom” by physicist Richard Feynman. And today this idea of Feynman has undergone immense development, with numerous methodologies being developed to synthesize nanoparticles of particular shape and size depending on specific requirements. Nanoparticles are of great scientific interest as they bridge the gap between bulk materials and atomic or molecular structures.

Zinc (Zn), chemical element, a low-melting metal of Group 12 (IIb) of the periodic table, that is essential to life and is one of the most widely used metals. Zinc is of considerable commercial importance. The chief zinc mineral is the sulfide sphalerite (zinc blend), which, together with its oxidation products smithsonite and hemimorphite, constitute nearly all of the world’s zinc ore. Zinc is an essential trace element in the human body, where it is found in high concentration in the red blood cells as an essential part of the enzyme carbonic anhydrase, whichromotes many reactions relating to carbon dioxide metabolism. The zinc present in the pancreas may also aid in the storage of insulin thus making it an important element.

Zinc oxide is an inorganic compound with the formula ZnO. ZnO is a white powder that is insoluble in water. Zinc oxide has been widely studied since 1935. Much of our current industry relies upon ZnO. Several metal nanoparticles such as silver, copper, gold, iron etc., has been explored so far. Since much research has been done already in those metal nanoparticles, the current study focused on zinc oxide nanoparticle. Zinc oxide is considered as multi-task metal oxide which can be used as Nano scale due to its unique physical, chemical and biological properties. Zinc oxide nanoparticles has a wide application in various fields such as optical, piezoelectric, mechanical, thermodynamic, electrodynamics, electromagnetic and gas sensing. It is also used as sensor, photo catalyst in the production of hydrogen, as fillers in rubber industry etc as they have enhanced pyro electric properties. ZnO has large excitation binding energy (60 MeV) which allows UV lasing action to occur even at room temperature and ZnO with Oxygen vacancies exhibits an efficient green emission. They also find applications in the pharmaceutical industry, cosmetic industry, solar cells and also as semiconductors. Furthermore, zinc oxide nanoparticle also act as good antimicrobial agent as they show antimicrobial activity against many pathogenic organisms like *Escherichia coli, Pseudomonas aeruginosa, Campylobacter jejuni*,etc.[6, 7]. When compared with other nanoparticles ZnO nanoparticles are less toxic and safe so they find increased applications in industries like food where they aused in packaging and processing of meat and vegetables. Thus because of the various properties of ZnO it is an interesting system to study thus making its synthesis a top priority.

II. EXPERIMENTAL

A. Glassware and chemicals

Glassware fitted with interchangeable standard conical ground joints were used throughout. All glassware were cleaned thoroughly with tap water followed by double distilled water, acetone and dried in an electrical oven at 110-120^{0}C for 2-3 hours prior to each

experiment. Calibrated pipettes and volumetric flasks were used. Apart from this measuring cylinders and beakers were also used. All the reactions were carried out using a magnetic stirrer kept at a specific rpm and temperature.
The Analytical Grade (AR) chemical used throughout the experiment was Zinc Sulphate Heptahydrate (assay 99%), its detail are as follows.
The final products have been characterized using UV-Visible, FTIR, and XRD techniques.

III. SYNTHETIC METHODOLOGY

Synthesis of Zinc Oxide (ZnO) nanoparticles
Physical characterization using, UV-visible spectroscopy, FTIR, XRD.

A. Materials

Leaves of *Trachyspermum ammi* and *Citrus aurantifolia* were collected from its natural habitat from nearby Kamothe village, Raigad district and Vidyanagari campus of Mumbai University, Maharashtra. Zinc sulphate was purchased from S. d. fine-CHEM.

B. Methods

1) *Preparation of Leaf Extrac:* The leaves of *Trachyspermum ammi* and *Citrus aurantifolia* were cleaned and washed with double distilled water, to remove the dust particles and then to remove the residual moisture. The extract used for the reduction of zinc ions ($Zn^{2+)}$ to zinc nanoparticles (ZnO) was prepared by placing50g of washed dried fine cut leaves of *Citrus aurantifolia* and *Trachyspermum ammi* in separate 250ml glass beaker along with 100ml of sterile distilled water. The respective mixture was then boiled for 60mins until the color of the aqueous solution changed from watery to light yellow. The extracts were cooled to room temperature and filter paper. The respective extracts were stored in refrigerator in order to be used for further experiments.
2) *Synthesis of ZnO nanoparticles:* For the synthesis of nanoparticle 50ml of *Citrus aurantifolia* leaf extract and 50ml of *Trachyspermum ammi* leaf extract were taken in separate beaker. They were boiled respectively to60-80^{o}C using a stirrer heater. 5g of Zinc Sulphate was added to the respective solution as the temperatures reached 60^{o}C. These respective mixtures were boiled until it reduced to a less than half and color change was observed. The solution was filtered dried and the residue obtained were then collected in a ceramic crucible and heated in an air heated furnace at 400^{o}C for 2 hrs. White colored powder was obtained for *Trachyspermumammi* leaves were as a Grey color powder of *Citrus aurantifolia* leaves. They were carefully collected and packed for characterization.

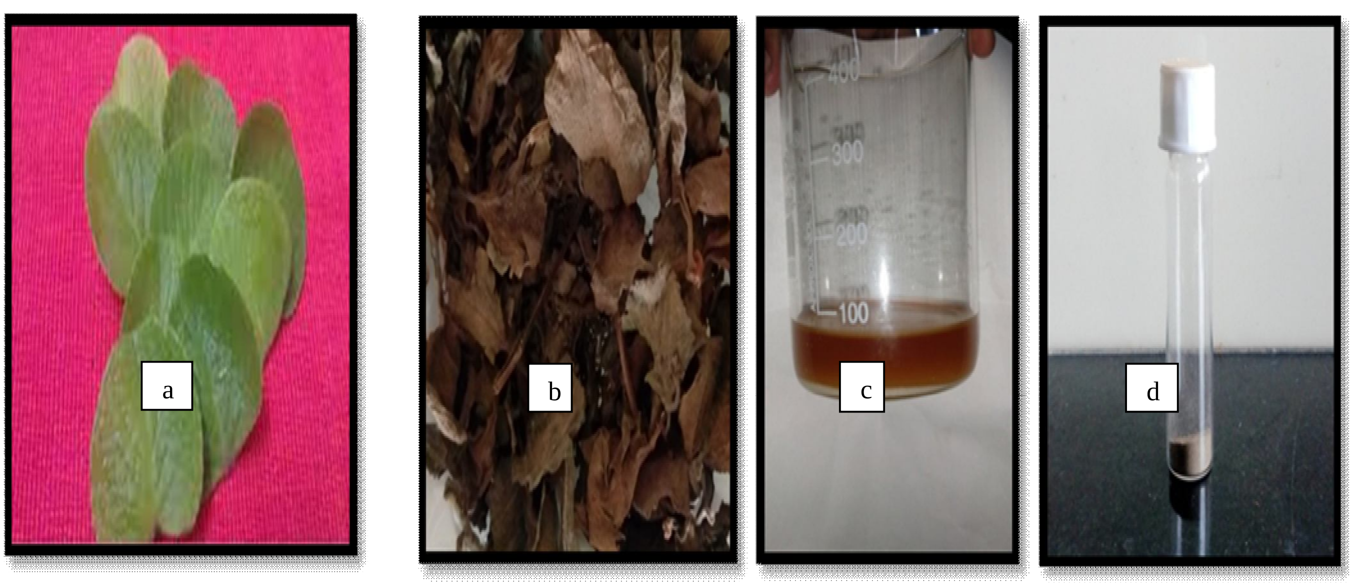

Fig1: (a) Fresh Ajwain leaves (b) Dried leaves (c) Leaf Extract (d) ZnO Nanoparticle

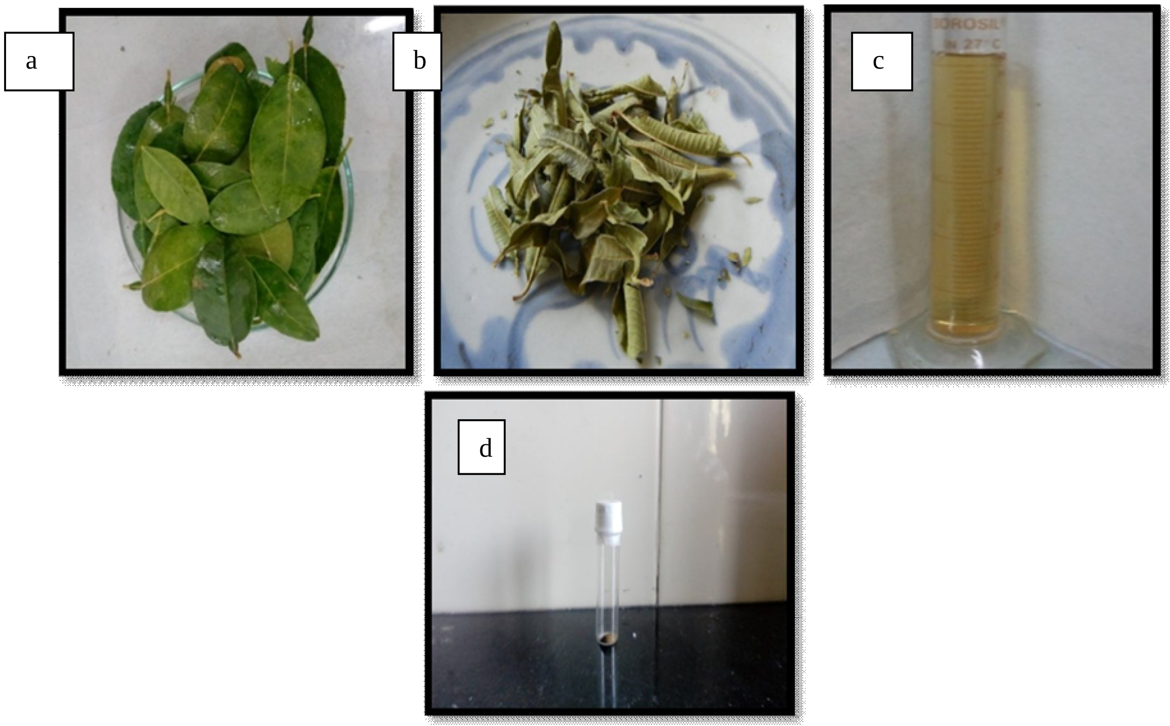

Fig2: (a) Fresh Lime leaves (b) Dried Leaves (c) Leaf Extract (d) ZnO Nanoparticles

IV. RESULT AND DISCUSSION

A. Uv-visible spectrum:

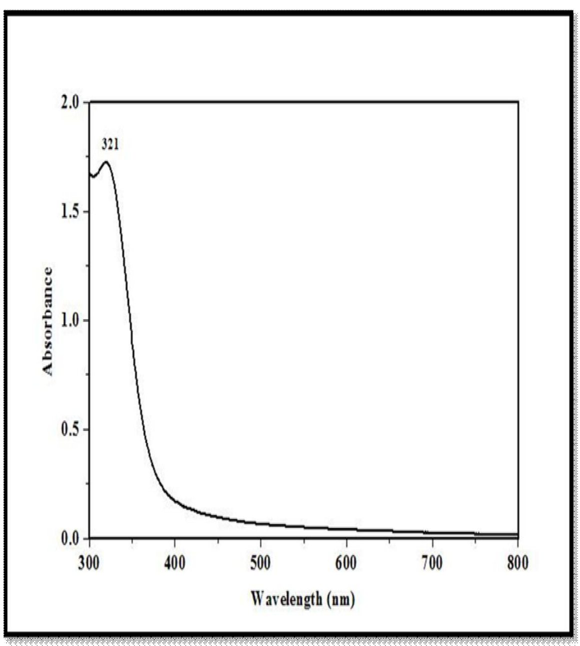

Fig .1

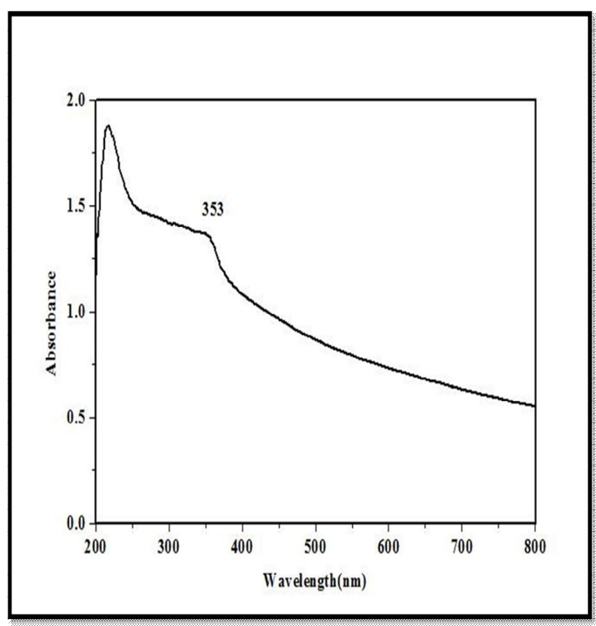

Fig. 2

Fig.1 and Fig.2 are the UV –Vis Spectra of Aqueous extract of *Trachyspermum ammi and Citrus aurantifolia*. They were obtained by dispersion of the respective ZnO NPs in ethanol. Typical absorption at 353nm is observed in the absorption spectrum for

Trachyspermum ammi and absorbance peak at 321nm for Citrus aurantifolia. Both of which show a blue shift with respect to the absorption edge appearing at 380nm[14]at room temperature. It is clear that the absorption edge systematically shifts to the lower wavelength or higher energy with decreasing size of the nanoparticle. This pronounced and systematic shift in the absorption edge is due to the quantum size effect.

B. Ftir

1) Interpretation of IR data:

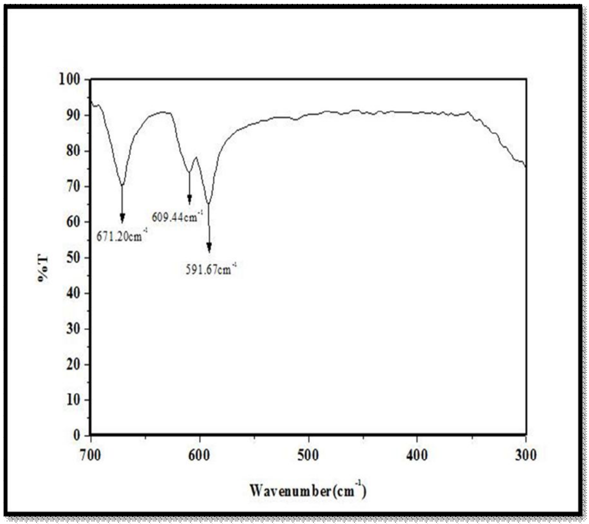

Fig.3

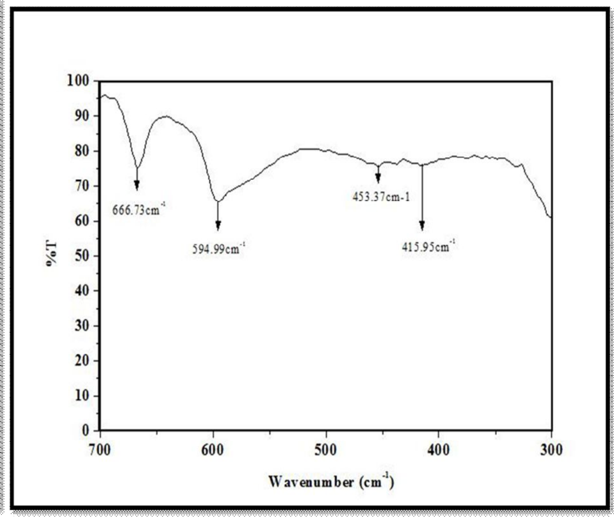

Fig4

Fig.3 and Fig.4 show the IR spectrum of ZnO NPS obtained from aqueous extract of Trachyspermum ammi and Citrus aurantifolia respectively. The IR spectrum was taken using a Perkin Elmer FT –IR instrument operating at a resolution of 700-300cm-1(Far IR region) in the percent transmittance mode. In both the spectra's the peak in the region between 400 and 600 cm^{-1} is allotted to Zn–O[15]i.e. the absorption at 591.67cm^{-1} in Fig.3 and the absorption peaks at 415.95cm^{-1},453.37cm^{-1},594.99cm^{-1} in Fig.4 identifies the presences of ZnO NPs. Apart from this the Absorption peaks at 609.44cm^{-1},671.20cm^{-1} in Fig.3 and 666.73cm^{-1} in Fig.4represent the O-H bending vibration of Alcohol/ Phenols.

2) XRD data analysis

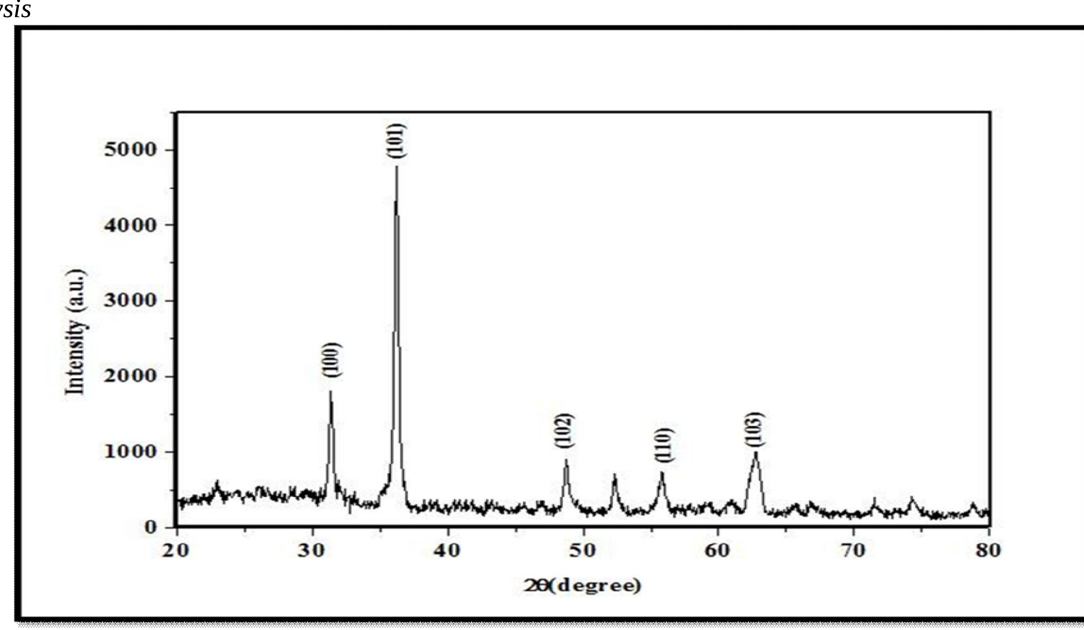

Fig.5: XRD pattern of Hexagonal ZnO (JCPDS Card No. 00-036-1451) from Trachyspermum ammi.

The XRD pattern shown above, Fig.5 is for Hexagonal ZnO obtained by green synthesis from *Trachyspermum ammi*. The pattern consists of several peaks within the region between 2θ, 20°–80°. The determined characteristic [hkl] planes are [100], [101], [102], [110], and [103] attributed to reflections of hexagonal phase of ZnO which was compared with JCPDS Card No. 00-036-1451.

The average grain size (D) was calculated from Scherer's formula.

$$D = 0.89\ \lambda / \beta \cos\theta$$

Where, $\lambda = 1.54060\ A^0$ (Cu K_α) and β is FWHM (in radians) at the diffraction angle.

The calculated average grain size using (101) diffraction peak was found to be 26.14 nm.

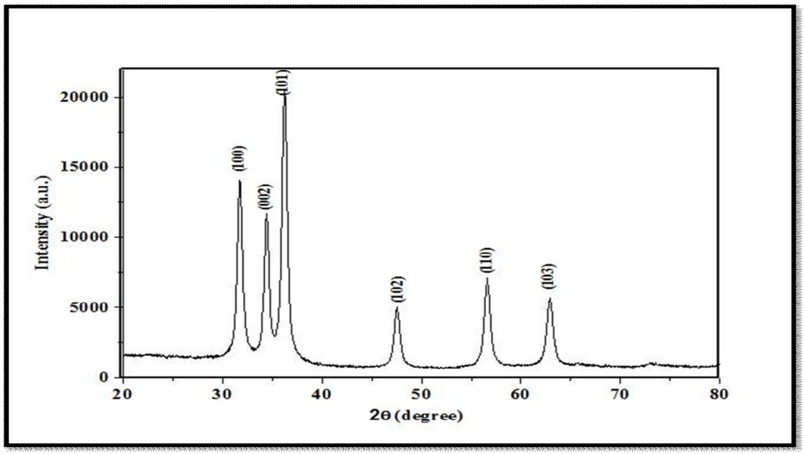

Fig.6: XRD pattern of Hexagonal ZnO (JCPDS Card No. 00-036-1451) from Citrus aurantifolia.

The XRD pattern shown above, Fig.6 is for Hexagonal ZnO obtained by green synthesis from *Citrus aurantifolia.* The pattern consists of several peaks within the region between 2θ, 20°–80°. The determined characteristic [hkl] planes are [100], [002], [101], [102], [110], and [103] attributed to reflections of hexagonal phase of ZnO which was compared with JCPDS Card No. 00-036-1451.

The average grain size (D) was calculated from Scherer's formula.

$$D = 0.89\ \lambda / \beta \cos\theta$$

Where, $\lambda = 1.54060\ A^0$ (Cu K_α) and β is FWHM (in radians) at the diffraction angle.

The calculated average grain size using (101) diffraction peak was found to be 18.35nm.

V. CONCLUSION

ZnO NPs was synthesized by the green synthesis method using Trachyspermum ammi and Citrus aurantifolialeaf extract is simple, eco-friendly, non-toxic and cost effective way. The prepared ZnO NPs were characterized using several techniques. UV- Visible and FTIR support the formation of nanoparticles. Structural analysis was done using XRD, so the size of nanoparticles was about 26nm using Trachyspermum ammi leaf extract and about 18nm using Citrus aurantifolia. Both the plants phytochemical with antioxidant properties are accountable for the synthesis of Zinc oxide nanoparticles. The eco-friendly high efficient ZnO nanoparticles prepared from Trachyspermum and Citrus leaf extract are expected to have more extensive application in biotechnology, sensors, medical, catalysis, optical devices, DNA labeling, drug delivery etc.

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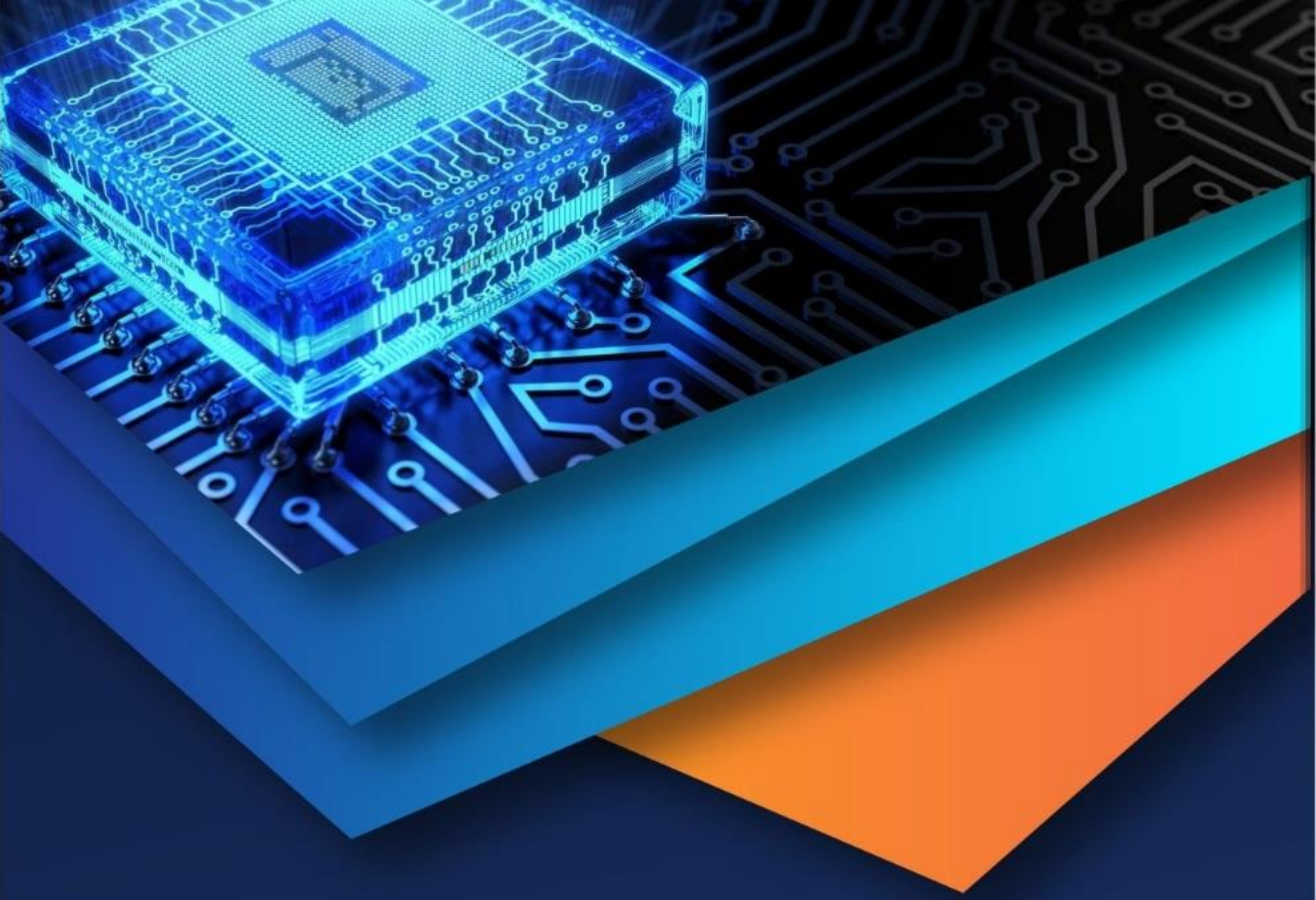

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