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Evaluating the Microhardness Profiles in Friction Stir Welding of Dissimilar Alloys

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Abstract: Friction stir Welding (FSW) advancement is used generally in the utilization of present-day flying and vehicle industry for predominant fundamental mentioning. Such a joining technique is displayed to avoid serious twists and the made excess weights are exhibited as low when it is stood out from the traditional welding structure. In this research, focus on to identify the parameters that will provide the dissimiliar alloys of aluminium AA6061 and AA8011 with good microhardness properties. From the current study microhardness strength of dissimiliar alloys of aluminium varies with the rpm, feed rate and shoulder diameter of the tool. At 2000 rpm and 15mm/min welding speed strength of joints is low and at high rpm 2400 and welding speed 20mm/min micro hardness strength is always low but at a rotation speed of 2200 rpm and welding speed 20 mm/min maximum strength of the weld joint . Hence at high rotational speed rise in the temperature occurs and cause dissolution of precipitates which lowers the hardness and at low rotational speed less heat generation at the tool workpiece interface causing less refinement of grains which lower the hardness value. During tensile strength test fracture and cracks occurs at weld center line.
Keywords; Friction stir welding (FSW), Aluminium alloys AA6061 and AA8011 ,Advancing side(AS), Retarding side(RS), Microhardness

I. INTRODUCTION

Friction stir welding (FSW) is a solid state welding below their melting point .Friction stir welding was developed in 1991 by the welding institute (TWI). Manufacturing of product requires the joining of materials at one point or the other during the product manufacturing. The process of welding with two basic types: solid-state welding and fusion welding. In fusion welding process, the joining process involves melting of the surfaces to be joined and upon solidification, the two materials become metallurgically bonded together. Solid-state welding on the other hand, affects the joining of materials at a temperature far below the melting point of the materials being joined. Solid-state welding and material processing are advanced welding and material processing technique that is developed, Friction stir welding and friction processing belong to a family of solid-state welding and material processing method with similar modes of operation.

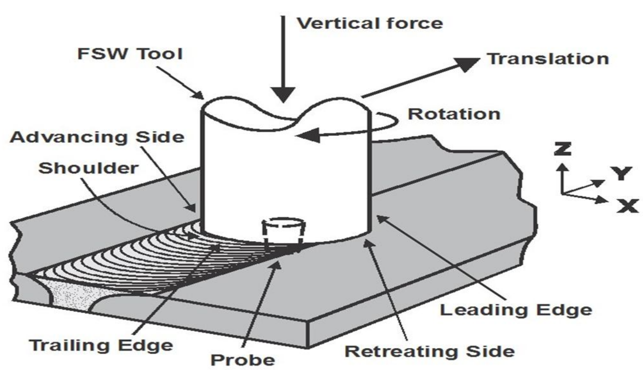

Fig No. 1: Schematic Diagram of Friction Stir Welding (FSW)

Saini et al., (2022) evaluated the FSW joint of magnesium alloy AZ61a, discovered that the maximum microhardness and tensile strength were seen 1800rpm and 2000 rpm respectively at a welding speed of 20mm/min. the development of equiaxed grains in the TMAZ and stir zone was revealed by microscope analysis of the joints due to the dynamic recrystallization.

Kimura et al., (2021) the author of this work examined the impacts of tensile strength on the weld face properties of friction stir welded joints between pure copper and stainless steel as well as the effect on the tensile strength at various friction welding setting.

Pratap Kumar J(2021) The literature review suggests that more research attempts were made to weld the combination of copper and aluminium alloys; therefore, different optimization techniques were to be studied to optimize welding process parameters.

Kimura et al., (2020) In this review, the creators analyzed the impacts of joint elasticity at various welding conditions, as well as the impacts of rigidity on the weld faying surface properties of grinding welded joints between austenitic hardened steel (AISI 304) and unadulterated copper. inspected the joining peculiarity and the joint elasticity at various welding conditions

Wang et al., (2019) The authors conducted a thorough investigation into the effects of linear friction welding parameters on the microstructure, texture distribution, and mechanical properties of titanium alloy joints made of Ti-6.5Al-3.5Mo-1.5Zr-0.3.

Reddy, (2017) The audit expected to evaluate the welding connection of AA1100 and Zr705 composite using restricted part examination. With respects to Friction stir welding AA1100 and Zr705 combination, it was settled that the assembling pressure should be 1.25 times the frictional strain. The survey perceived ideal working conditions for good scouring welding of AA1100 and Zr705 blend, deciding a frictional pressure of 25 MPa, frictional time of four seconds, rotational speed of 2000 rpm, and delivering type of 31.25 MPa.

The writing survey referenced above made it clear that while a lot of examination has been done on FSW for similar welding aluminium alloys but very work has been found to be on dissimilar Aluminium alloys and that needs to be indepth exploration. In this exploration work, effect of changing the speed and feed will evaluate as information factors for the welding joints.

II. EXPERIMENTATION

A. Research Objectives

To determine and evaluate the AA6061 and AA8011 joints Micro hardness of FSW.

B. Material,Tool, and FSW Parameters

In this experiment AA6061-T6 and AA 8011 alloys with dimension 150mm by 150mm by 6mm.

Table 1: Nominal composition ofAA6061

ALUMINIUM	97.9%
MAGNESIUM	1.0 %
SILICON	0.6%
COPPER	0.28%
CHROMIUM	0.2%
AND SOME TRACE NUMBER OF OTHER ELEMENTS	

Table 2: Material properties

Name of material	AA6061
Yield strength YS(MPA)	276
Ultimate tensile strength UTS (MPA)	310
Elongation e (%)	16
Micro hardness (HV)	165

Table.3: Nominal composition of AA8011

ALUMINIUM	97.3
IRON	0.6
SILICON	0.50
MANGANESE	0.20

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Table .4 Material **properties**

Name of material	AA8011
Yield strength (MPA)	240
Ultimate tensile strength UTS (MPA)	290
Elongation e (%)	16
Micro hardness (HV)	81

C. Tool Material

The tool made of H13 steel is used for joining aluminium dissimilar alloys. They are made up of carbon steel .In our experiment tool with cylindrical pin is used to create the weld with dimension of 18mm shoulder and 6mm pin.

FIG 1.1: cylindrical pin tool

D. Trial and Final Run

The tool cylindrical threaded pin used to complete the trial weld. At low welding speed 10mm/min and 1500 rpm vibration occurs in machine and after some trial increase in rpm and weld speed hence some significant values get in which welding occurs. At low rotational speed substance was not mixed properly and strength was terribly low. After some trail some values at which welding occurs smoothly and high Micro hardness values as shown in table no.5

Table No.5: Welding Parameters

Rotational speed(rpm)	2000	2000	2200	2200	2400	2400
Feed(mm/min)	15	20	15	20	15	20
Shoulder diameter(mm)	18	18	18	18	18	18

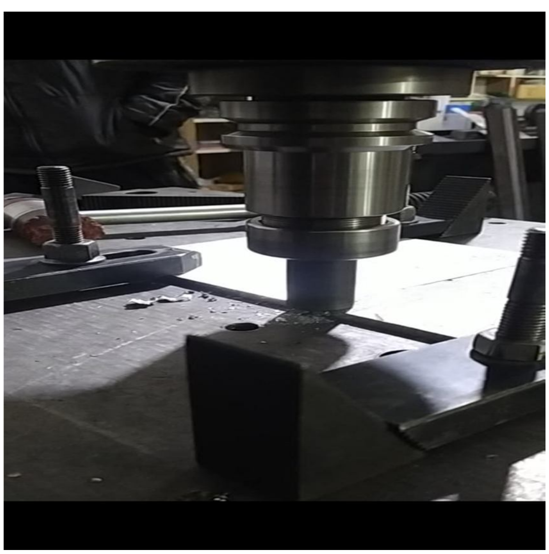

Fig 1.2 Trial welding

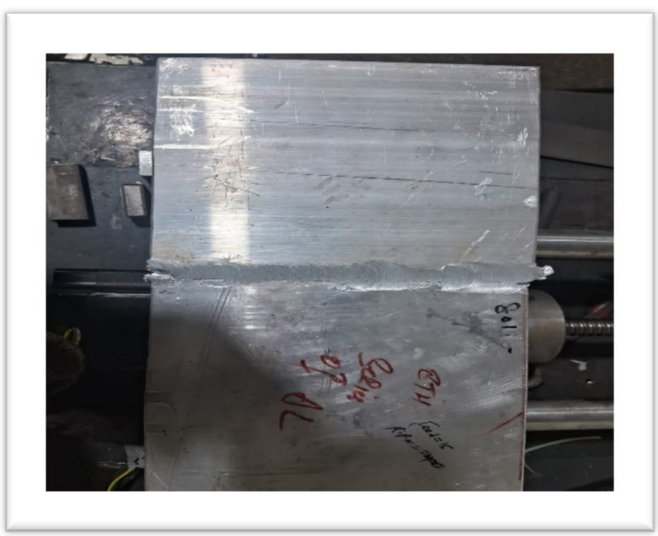

FIG 1.3 Final welding

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III. EXPERIMENTAL

CNC vertical milling machine (HMT CNC). The machine info are as follow;
axis limit X=560, Y=560,Z=450, Rotation =30-6000 rev/min
For this Friction-Stir Welding operation purpose in a Milling Machine, a milling fixture is required on which the plates which are to be welded is fastened. In this paper, developed a milling fixture and its clamping setup for a Vertical Milling Machine in which Friction-Stir Welding operations are to occur. The fixture was designed with required specifications. The screw clamps are designed in such a way to hold the work pieces rigidly during Friction-Stir Welding operation. Taking into account the lateral and transverse movement of the tool and work piece.in this process prepares a workpiece of dimension 150mm by 6mm by150mm of two dissimilar alloys of aluminium AA6061 AND AA8011 by varying various parameters with shoulder diameter 18mm and 6mm pin then analysis the micro hardness and micro structure of this welded alloy

Fig 1.4: CNC MILLING MACHINE for FSW Setup**.**

IV. MICRO HARDNESS TESTING MACHINE

Typically, microhardness testing uses an indenter probe which is pushed into a surface under a defined load for a determined amount of time. This process will generally leave an indentation in the surface, and this is then measured to determine hardness of the sample .the force is applied for ten second only.

Specification
1.depth range
Depth resolution above noise floor <0.03mm
Depth noise floor <3mm
Max indention depth ;500 m

Load range
Test force 10mN-30N
Load resolution above noise floor<6uN
Loading rate <2um/sec
Contact force hold time ;10-60s

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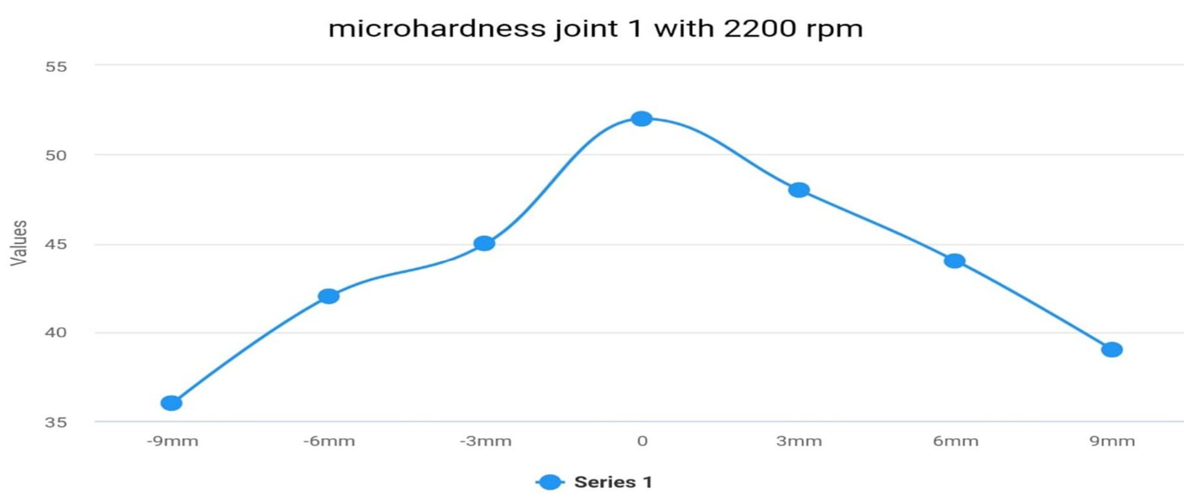
FIG 1.5 Microhardness Testing Machine

V. RESULT AND DISSCUSSIONS

For the joint 1 at RPM=2000 and welding speed =15mm/min the hardness is maximum at the centre then the retarding side(RS) and advancing side(AS). Microhardness varies with the distance as shown in table

Table No.6

-9mm	-6mm	-3mm	0	3mm	6mm	9mm
36	42	45	52	48	44	39



Graph N0 1

For the joint 2 at 2200RPM and 15mm/min welding speed the micro hardness is

Table No.7

-9mm	-6mm	-3mm	0	3mm	6mm	9mm
34.8	34.6	32.6	52	30	30.3	31.8

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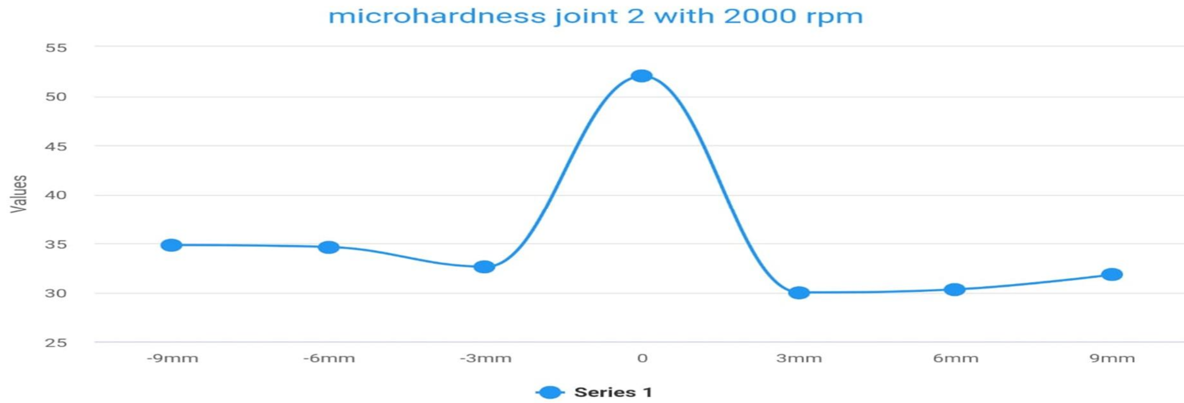


Graph no. 2

For joint 3 RPM=2400 and welding speed 15mm/min the micro hardness is

Table NO.8

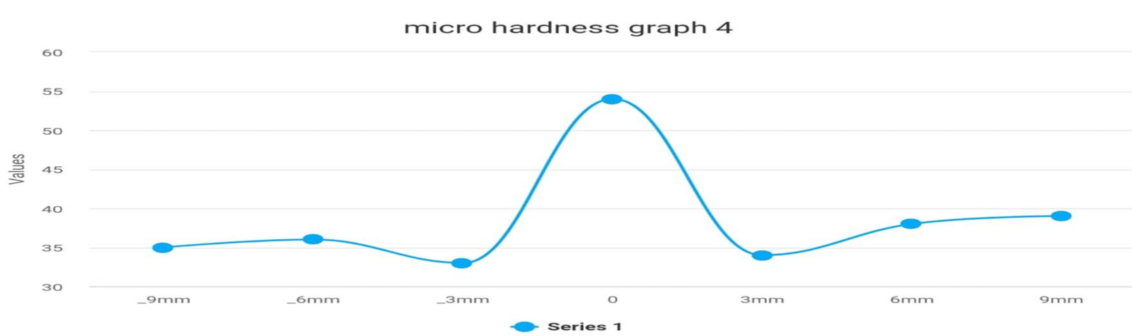
-9mm	-6mm	-3mm	0	3mm	6mm	9mm
32.2	30.2	33.4	47	35.7	36.9	37.8

Graph N0 .3

For the joint 4 at 2000RPM and 20mm/min welding speed the micro hardness is

Table No.9

-9mm	-6mm	-3mm	0	3mm	6mm	9mm
35	36	33	54	34	38	39

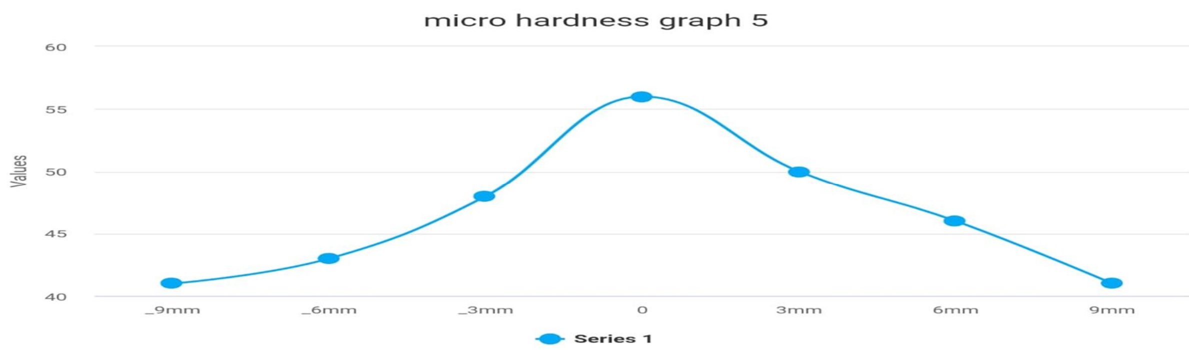


Graph No.4

For the joint 5 at 2200RPM and 20mm/min welding speed the micro hardness is

Table N0.10

-9mm	-6mm	-3mm	0	3mm	6mm	9mm
41	43	48	56	50	46	41

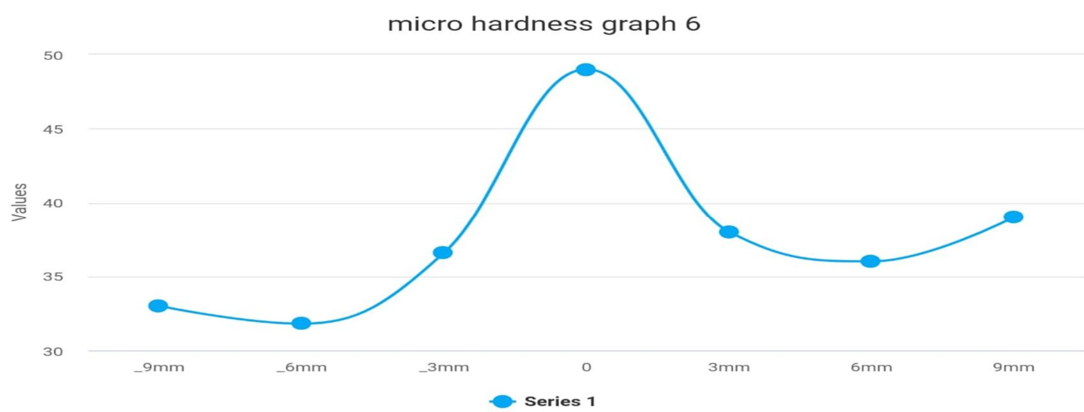


Graph No.5

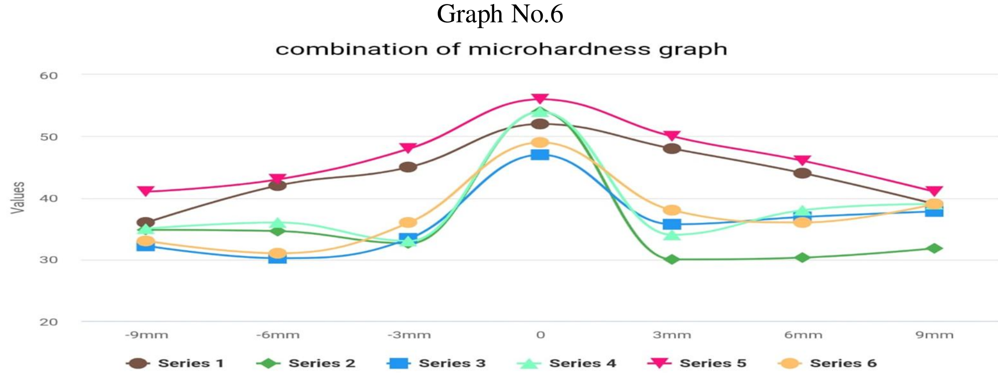
For the joint 6 at 2400RPM and 20mm/min welding speed the micro hardness is

Table N0.11

-9mm	-6mm	-3mm	0	3mm	6mm	9mm
33	31	36.6	49	38	36	39



Graph No.6



VI. CONCLUSIONS

From the current study the micro hardness of dissimilar alloys of aluminium varies with the rpm ,feed rate and shoulder diameter of the tool. At 2000 rpm and 15mm/min welding speed is low and at high rpm 2400 and welding speed 20mm/min microhardness is always low but finally at a rotation speed of 2200 rpm and welding speed 20 mm/min maximum micro hardness of the weld joint . Hence at high rotational speed rise in the temperature occurs and cause dissolution of precipitates which lowers the hardness and at low rotational speed less heat generation at the tool workpiece interface causing less refinement of grains which lower the hardness value.

VII. FUTURE SCOPE

The future scope of FSW of dissimilar alloys of aluminium AA6061 And AA8011 are

1) Axial force can be varied to observe the effect on micro structure view
2) Friction stir spot welding can be used along with pre heating process

VIII. ACKNOWLEDGMENT

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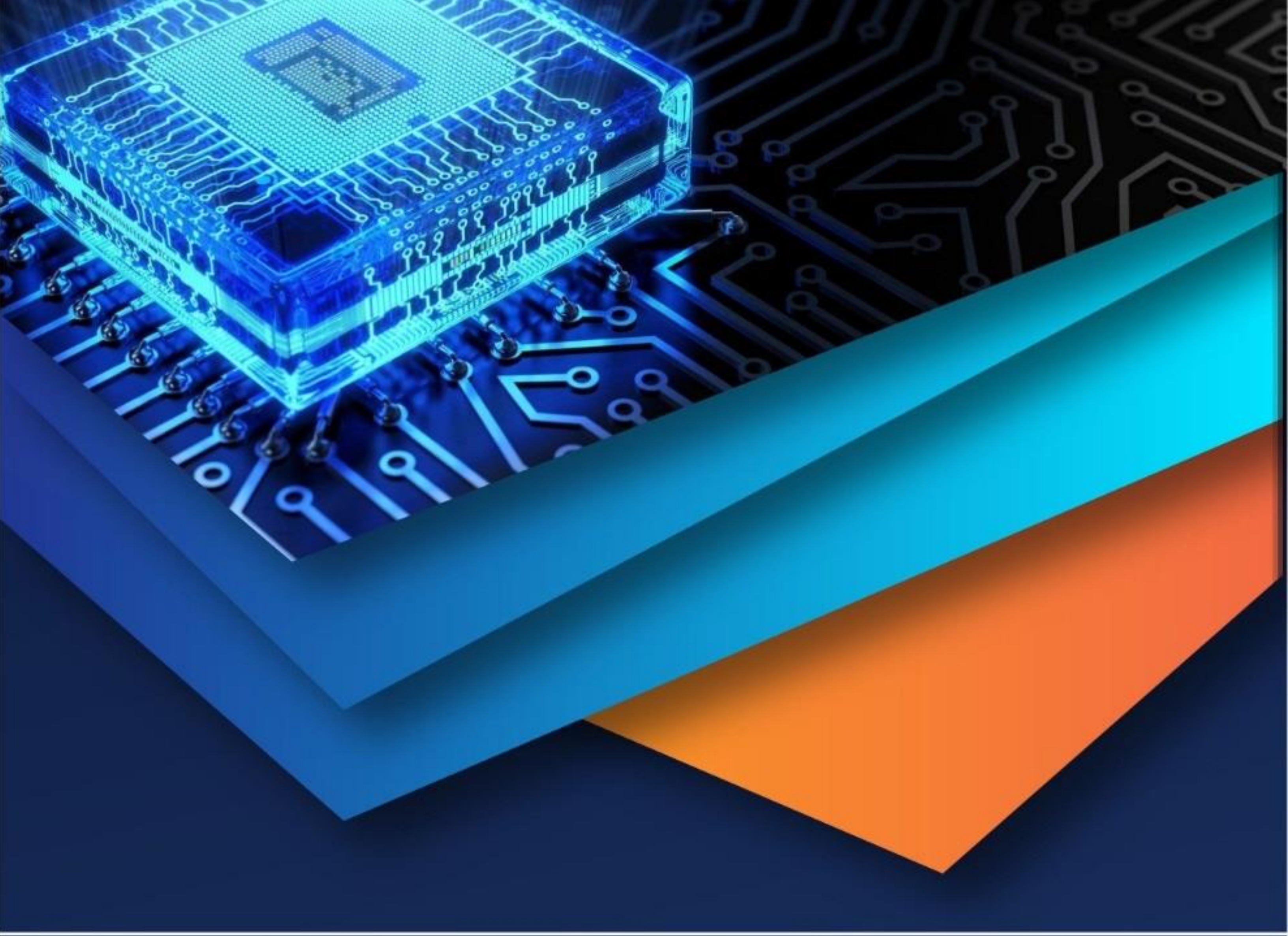

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