Retraction

Retraction: Friction Stir Welding of dissimilar Materials (AA2024 & AA6063) and Investigation of Mechanical Properties (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012029)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Friction Stir Welding of dissimilar Materials (AA2024 &AA6063) and Investigation of Mechanical Properties

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Abstract. Frictional heating system and permanent distortion under melting heat is a technique behind Friction stir welding (FSW) of the materials. Compared to arc welding, Friction stir welding has higher strength, good fatigue life, and lower distortion, less residual stress, low corrosion and non-defect. The main aim of the investigation is to examine the influence of mechanical characteristics of dissimilar aluminium alloys (AA2024 & AA6063 aluminium alloy) in joining parameters. Properties like hardness and tensile testing helps us to investigate the mechanical performance of the dissimilar aluminium alloys welded through different welding speed, tool rotation speed and the applied axial load.

Keywords: Aluminium alloys, Friction stir welding, Hardness, Tensile strength

1. Introduction
Aluminium 2 series alloys have good strength and machinability used in shipbuilding for making critical structure materials. Al alloy has good strength to weight ratio and good formability which help us to use Al in many industries aerospace, and automobile [1-4]. Fusion welding is only possible way to weld the 2 series Al alloy on special consideration is required. Because it may cause hot cracking, alloy segregation, partially melted zone and porosity. The consequence of the pulse generation results having proven that now the combining of superior properties Aluminium alloy also wasn't consistent. A world first process developed by G2 Alloy [5-9] called Welding process (FSW) has shown that this is capable of welding dense materials, including such aluminium and magnesium alloys in a fast and effective manner. The latest titanium composition's pulse rate findings illustrate then that the inclusion of an alloy of full authority, titanium for example, is still not reliable, and has been that through an application of the required heat and a subsequent
chemical treatment - an alloy covering in two minutes can be especially well welded between two parts (two distinct discontinuous processes) [10-15].

Therefore, high standard weld is obtained when the parameters of the FSW are under control. Many authors performed an experiment to research the effect of high-strength and super endurance AlZn-Mg-Cu alloys on welding conditions such as the morphology and mechanical characteristics of joints. When reducing their magnetic field applied on the iron powder without heating the mixture too much, it has contributed in reductions of the size distribution in the inner region and followed by the formation of impurities [16-20]. The heating of the material caused the H zone to be fundamentally changed and harmed due towards temperature rise. Few authors experimented AA2198-T6 aluminium-lithium alloy joints effect on the process parameter and fatigue properties of FSW. The result of this investigation showed because whenever growing their device's spinning intensity to machining fan speed, there'd be a reduction in the stability of such joints and resilience of the steel. There was also a change in fracture mode, i.e., from brittle to ductile mode [21-25]. Experimenter defined 6082-T651 Aluminium alloy as the material that is affected by the FSW parameters which greatly affect the mechanical characteristics. From his analysis, the weld quality formation depends on the welding speed and plays a major role and also, the maximum tensile strength was noted as 263MPa, which was 85% of base metal [26-30]. It is clearly noted that, a plenty of researches were taken into an account to find the grain size properties and elongation characteristics for various grades of alloy of aluminium with individual friction stir welding parameter. To the best knowledge, revolving and joining velocity of various aluminium alloys considered for investigation and experimentation for FSW of unlike materials [31-33].

1.1 Aluminum alloy 6063
Aluminium alloy AA6063 (also known as Architectural alloy) is a medium strength alloy which has a mechanical property of fine finishing of superficial, excess opposition to corrosion in which the maximum well suited for joining process. The method of anodizing is achieved clearly. Table 1 and table 2 shows the Material composition.

| Table 1. Material Composition of AA 6063 [31] |
|-----------------------------------------------|
| Alloying Elements% | Si | Fe | Cu | Mn | Mg | Zn | Ti | Cr | Al |
| AA 6063           | 0.2 to 0.6 | 0.35 | 0.1 | 0.1 | 0.45 to 0.9 | 0.1 | 0.1 | 0.1 | Balance |

1.2 Aluminium alloys 2024

| Table 2. Material Composition of AA 2024 [33] |
|-----------------------------------------------|
| Alloying Elements% | Cr | Cu | Fe | Mn | Si | Zn | Al |
| AA 2024           | 0.1 | 3.8-4.9 | 0.5 | 1.2-1.8 | 0.3-0.9 | 0.5 | 0.25 | Remaining |
2. **Experimental Setup**

![Figure 1. Friction stir welding [10]](image)

Friction stir welding was conducted on a friction stir welding machine. Let consider a work material of dimensions 100 x 50 x 6mm and a FSW tool of dimensions 5.8 mm length with 20mm diameter shoulder and 6 mm pin diameter. After welding trails, parameters are setted. With the help of special fixture, a pair of work piece is clamped tightly on the table of milling machine. And a rotating non-consumable tool pin plunges into the outermost surfaces as far as the shoulders touches the work material's surface. Then a heating cycle of a few minutes begins, and the tray pushes at an acceptable pace along the path set by the direction of heat. When the joint is raised, the new being applied force perpendicular to the joint [12, 17, 21].

Test heat flux will be taken at the free tools system to be controlled. If the tool projection never reaches the angled side of the retained tool body, the actual tool is extracted. Rotational pressure with uniform heat is created is when weaving process insert also with the elbow swings, and fracture energy attributable to the mixing of the substance it around pin, making the weld.

Universal Testing Machine is used to estimate the tensile strength of the specimen which follows the standard ASTM E08 which cut the specimen in the direction normal to weld in each welded sample plate. Samples of Micro hardness test by Vickers hardness to measure the hardness of the welded specimens [1720].

3. **Result and Discussion**

3.1 Tensile Test

As per the ASTM E08 standards, tensile strength of welded specimen was measured. A set of nine specimens were prepared for the experiment and test with a axial loads by varying rotational and welding speeds. The readings extracted used in the image represents data gathered again from flexural of the tested joints (Figure 1). The welding speed of 30mm/min, shows the good tensile strength of the specimen on a particular welded part were found, and also noted that there was an increase in tensile strength due to distribution of uniform temperature at weld region by tool while increase in rotational speed. But, because of the higher and increased rotational speeds above 1400 rpm, distortion was found at the welded regions which caused an adverse effect. Figure 2 shows the specimen of trails. The tensile strength of 122 MPa in the trail 7 shows the good result with rotational speed of 1400rpm, welding speed of 30mm/min and the axial load of 8kN. Table 3 shows the FSW process Parameters and the Tensile strength of the Trails. Figure 3 shows the tensile strength.
| No of trails | Rotational speed (rpm) | Welding speed (mm/min) | Axial load (kN) | Tensile strength (N/mm²) |
|--------------|-----------------------|------------------------|----------------|-------------------------|
| 1            | 1000                  | 30                     | 10             | 75                      |
| 2            | 1000                  | 40                     | 9              | 77                      |
| 3            | 1000                  | 50                     | 8              | 88                      |
| 4            | 1200                  | 30                     | 9              | 117                     |
| 5            | 1200                  | 40                     | 8              | 106                     |
| 6            | 1200                  | 50                     | 10             | 100                     |
| 7            | 1400                  | 30                     | 8              | 122                     |
| 8            | 1400                  | 40                     | 10             | 117                     |
| 9            | 1400                  | 50                     | 9              | 86                      |

Table 3. FSW process Parameters and the Tensile strength of the Trails.

Figure 2. Specimen of Trail 1 to 9
3.2 Hardness Test

Using the Vickers hardness test, the hardness of the welded specimen was determined and the two distinct forces cover all the testing requirements in the range of micro (10g to 500g) and macro (0.1kg to 0.5 kg). Vickers hardness test made with same indenter for the range of hardness for the metals which is continuous in hardness values (typically HV100 to HV500). Different parameters link welding speed, rotational speed, welded nine specimen material are tested. The below figure 4 and 5 shows the hardness values of the specimens retrieved from hardness test. The result shows the increase in welding speed above the 30mm/min with the rotational speed of 1400rpm decreases the hardness value. Hence welding speed is critical above 30mm/min with the hardness result of 181HV of the specimen. Table 4 shows the Hardness value.

Table 4. Hardness values of Base Materials and Welded area.

| Number of trials | Base material AA2024 | Welded area | Base material AA6063 |
|------------------|----------------------|-------------|----------------------|
| 1                | 126 HV               | 153 HV      | 54 HV                |
| 2                | 64 HV                | 171 HV      | 57 HV                |
| 3                | 63 HV                | 63 HV       | 65 HV                |
| 4                | 126 HV               | 160 HV      | 63 HV                |
| 5                | 64 HV                | 163 HV      | 44 HV                |
|   |   |   |   |
|---|---|---|---|
| 6 | 71 HV | 171 HV | 55 HV |
| 7 | 126 HV | 181 HV | 63 HV |
| 8 | 90 HV  | 163 HV | 56 HV |
| 9 | 123 HV | 162 HV | 60 HV |

Figure 4. Hardness Value for Trail (1-9) graph

Figure 5. Hardness specimen for Trail 1 to 9

4. Conclusion
Many areas like electronic equipment, machine construction, automotive parts, aerospace industry, and pressure vessels in cryogenic application, structural elements of machine and cooking utensils is impossible without Aluminium alloys. The 6xxx alloys is composed of silicon and magnesium elements which results in...
in medium levels of strength, good corrosion resistance and also has good formability and welding ability than other heat-treatable aluminium alloys. It is commonly known that Platinum is an extra electrons item in 2000 sequence, which also has higher durability and castability. But it has lower corrosion resistance which is a demerit than most other aluminium alloys. Good elevated temperature strength is a good property which many of these alloys build with. The investigation on the material characteristics of the AA2024 and AA6063 materials look promising, with the Route number 7 coming out as the top performer with either the revolving speed of 1400 rpm, effective tools of 122 MPa, injection pressure of 30 mm/min and elongation load of 8 kN.

References

[1] Rajkumar, S., Arulmurugan, B., Manikandan, M., Karthick, R. and Kaviprasath, S., 2017. Analysis of physical and mechanical properties of A3003 aluminium honeycomb core sandwich panels. In Applied Mechanics and Materials (Vol. 867, pp. 245-253). Trans Tech Publications Ltd.

[2] Rajkumar, S., Sivaraj, M., Rudrapati, R., Arulmurgan, B. and Muthuraman, S., Experimental and Finite-Element Analysis of Tee Joint’s Stiffness Characteristics of A3003 Honeycomb Core Sandwich Panels.

[3] Rajesh kumar L, Saravanakumar A, Bhuvaneswari V, JithinKurthan M P, Karthick raja N, Karthi P 2020 Tribological Behaviour of AA2219/MoS2 Metal Matrix Composites under Lubrication AIP Conference Proceedings 2207 020005

[4] Dietrich D., Nickel D., Krause M., 2011, Formation of intermetallic phases in diffusion welded joints of aluminium and magnesium alloys, J. Mater. Sci., 46, 357-364.

[5] V Bhuvaneswari, M Priyadharshini, C Deepa, D Bakji, L Rajeshkumar, M Ramesh 2021 Deep learning for material synthesis and manufacturing systems A review, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2020.11.351.

[6] Mishraa R.S., Ma Z.Y., 2005, Frictions stir welding and processing, Mater. Sci. Eng., 50, 1-78.

[7] Nandan R., DebRoy T., Bhadeshia H.K.D.H.,2008, Recent advances in friction-stir welding process, Weldment structure and properties, Prog. Mater. Sci., 53, 980-1023.

[8] Scialpi A., De Filippis L.A.C., Cavaliere P., 2007, Influence of shoulder geometry on microstructure and mechanical properties of friction stir welded 6082 aluminum alloy, Mater. Des., 28, 1124–1129.

[9] Rajeshkumar, L R K 2018 Dry sliding wear behavior of AA2219 reinforced with magnesium oxide and graphite hybrid metal matrix composites, Int J Eng Res Technol, 6 3-8.

[10] Xu W.F., Liu J.H., Luan G.H., Dong C.L.,2009 Temperature evolution, microstructure and mechanical properties of friction stir welded thick 2219-O aluminum alloy joints, Mater. Des., , 30, 1886–1893.

[11] H. Anandakumar and K. Umamaheswari, A bio-inspired swarm intelligence technique for social aware cognitive radio handovers, Computers & Electrical Engineering, vol. 71, pp. 925–937, Oct. 2018. doi:10.1016/j.compeleceng.2017.09.016

[12] R. Arulmurugan and H. Anandakumar, Early Detection of Lung Cancer Using Wavelet Feature Descriptor and Feed Forward Back Propagation Neural Networks Classifier, Lecture Notes in Computational Vision and Biomechanics, pp. 103–110, 2018. doi:10.1007/978-3-319-71767-8_9

[13] Haldorai, A. Ramu, and S. Murugan, Social Aware Cognitive Radio Networks, Social Network Analytics for Contemporary Business Organizations, pp. 188–202. doi:10.4018/978-1-5225-5097-6.ch010

[14] R. Arulmurugan and H. Anandakumar, Region-based seed point cell segmentation and detection for biomedical image analysis, International Journal of Biomedical Engineering and Technology, vol. 27, no. 4, p. 273, 2018.
[15] Upadhyay P., Reynolds A.P., 2010, Effects of thermal boundary conditions in friction stir welded AA7050-T7 sheets, Mater. Sci. Eng. A, 527, 1537-1543.

[16] Fu R.D., Sun Z.Q., Sun R.C., Li Y., Liu H.J., Lei L., 2011, Improvement of weld temperature distribution and mechanical properties of 7050 aluminum alloy butt joints by submerged friction stir welding, Mater. Des. 32, 4825-4831.

[17] L Rajeshkumar, V Bhuvaneswari, B Pradeepraj, M Praveen pauldurai, C Palanivel, S Sandeep kumar 2020, Design and Optimization of Static Characteristics for a Steering System in an ATV, IOP Conf. Ser.: Mater. Sci. Eng., 954 012009.

[18] Mofid M.A., Abdollah-Zadeh A., MalekGhaini F., 2012, The effects of water cooling during dissimilar friction stir welding of Al alloy to Mg alloy, Mater. Des. 36, 161-167.

[19] Zettler R., 2006, Dissimilar Al to Mg alloy friction stir welds, Adv. Eng. Mater., 8, 415-421.

[20] McLean A.A., Powell G.L.F., Brown I.H., Linton V.M., 2003, Friction stir welding of magnesium alloy AZ31B to aluminum alloy 5083, Sci. Technol. Weld. Join. 8, 462-464.

[21] Zhang F., Su X., Chen Z., Nie Z., 2015, Effect of welding parameters on microstructure and mechanical properties of friction stir welded joints of a super high strength Al–Zn–Mg–Cu aluminum alloy, Mater. Des. 67, 483-491.

[22] Rajesh Kumar, L Saravanakumar, A Bhuvaneswari V, Gokul C, Dinesh Kumar D, JithinKarunan, M P 2020 Optimization of wear behaviour for AA2219-MoS2 metal matrix composites in dry and lubricated condition, Mater. Today: Proc., 27(3), pp. 2645–2649.

[23] Mao Y., Ke L., Liu F., Huang Ch., Chen Y., Liu Q., 2015, Effect of weldingparameters on microstructure and mechanical properties of frictionstir welded joints of 2060 aluminum lithium alloy, Int. J. Adv.Manuf. Technol., 81, pp. 1410-1431.

[24] Rajesh Kumar L; Amirthagadeswaran, K S 2020, Corrosion and wear behaviour of nano Al2O3 reinforced copper metal matrix composites synthesized by high energy ball milling, Part Sci. Technol. 38(2), 228–235.

[25] Singh G., Singh K., Singh J., 2011, Effect of Process Parameters onMicrostructure and Mechanical Properties in Friction Stir Weldingof Aluminum Alloy, Trans. Indian. Inst. Met., 64, pp 325-330.

[26] Saravanakumar A, Rajeshkumar L, Balaji D et al 2020 Prediction of Wear Characteristics of AA2219-Gr Matrix Composites Using GRNN and Taguchi-Based Approach. Arab J Sci Eng, 45 pp 9549–57

[27] Manikandan, M., Arivazhagan, N., Arivarasu, M., Mageshkumar, K., Rajan, D.N., Murugan, B.A., Prasanth, P., Sukumar, S. and Vimalanathan, R., 2017. Analysis of metallurgical and mechanical properties of continuous and pulsed current gas tungsten arc welded alloy C-276 with duplex stainless steel. Transactions of the Indian Institute of Metals, 70(3), pp 661-669.

[28] A Saravanakumar, S Sivalingam, L Rajesh kumar 2016 Dry sliding wear behaviour of AA2219/Gr metal matrix composites, Mater. Today: Proc., 5, pp. 8321–8327.

[29] L Rajeshkumar, K S Amirthagadeswaran 2019 Variations in the properties of copper-alumina nanocomposites synthesized by mechanical alloying, Mater. Technol. 59 (1), pp 57–63.

[30] Arulmurugan, B. and Manikandan, M., 2018. Improvement of Metallurgical and Mechanical Properties of Gas Tungsten arc Weldments of Alloy 686 by Current Pulsing, Transactions of the Indian Institute of Metals, 71(12), pp 2953-2970.

[31] Arulmurugan, B., Modi, K., Sanjay, A.P., Yashwant, P.A., Rickwirth, N., Mohan, C.G., Subramani, P., Agilan, M., Manikandan, M. and Arivazhagan, N., 2019. Effect of post-weld heat treatment on the microstructure and tensile properties of electron-beam-welded 21st century nickel-based super alloy 686. Sādhanā, 44(2), p 38.
[32] L Rajesh kumar, A Saravanakumar, R Saravanakumar, S Sivalingam, V Bhuvaneswari 2018 *Prediction capabilities of mathematical models for wear behaviour of AA2219/MgO/Gr hybrid metal matrix composites*. International Journal of Mechanical and Production Engineering Research and Development, *8*, pp 393-399.

[33] M, Manikandan, Sasikumar P, Arul Murugan B, Sathishkumar M, and Arivazhagan N., *Microsegregation Studies on Pulsed Current Gas Tungsten Arc Welding of Alloy C-276*. Retracted