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Notice for the PhD Viva-Voce Examination

Mr Pratap Kumar J (Registration Number: 1982701), PhD scholar at the School of Engineering and Technology, CHRIST (Deemed to be University), Bangalore will defend his PhD thesis at the public viva-voce examination on Saturday, 27 July 2024 at 10.00 am in the CDI Conference Room, Block V, Bangalore Kengeri Campus, Bengaluru 560074.

Title of the Thesis	:	**Friction Stir Welding Process Parameters Optimization by Taguchi Analysis and Validating the Mathematical Model Using RSM for AA6101-C11000 Alloy Joints**
Discipline	:	**Mechanical Engineering**
External Examiner (Outside Karnataka)	:	**Dr Saikat Chaterjee** Professor and Director Department of Mechanical Engineering Sanaka Educational Trust's Group of Institutions Durgapur, West Bengal - 713212
External Examiner (Within Karnataka)	:	**Dr Padmaraj N H** Associate Professor Manipal Institute of Technology Udupi Karnataka - 576104
Supervisor	:	**Dr Anil Raj** Assistant Professor Department of Mechanical and Automobile Engineering School of Engineering and Technology CHRIST (Deemed to be University) Bengaluru-560074 Karnataka

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Registrar

Place: Bengaluru
Date: 16 July 2024

ABSTRACT

Friction Stir Welding (FSW) is a well-established joining method that offers significant advantages over traditional methods, including improved mechanical characteristics, less distortion, and environmental friendliness. Due to its solid-state nature, the heat produced through the welding mainly influences the features of joints in FSW. In this investigation, 2D and 3D models of the base metals and welding tool with different pin profiles were designed using SOLIDWORKS. Fixture was designed and manufactured in accordance with the specifications of the welding machine. ANSYS software was used to investigate the temperature distributions near the weld zones. The base metals AA6101 and C11000 of each 5 mm thickness with butt weld positioned, were joined by FSW mechanism with the help of OHNS steel tool with circular pin profile. Taguchi analysis was employed to optimize the FSW welding input process parameters, including tool rotational speed (rpm), feed rate (mm/min), and tool offset (mm), to determine their respective contribution (%) to the output response, namely ultimate tensile strength, micro Vickers hardness, Charpy impact load, and electrical conductivity to achieve the high joint strength. During experimental work using the Taguchi's design matrix, the maximum output response values were obtained when the input parameters were set to 1000 rpm, 50 mm/min and -1 mm. Taguchi analysis revealed that the tool rotational speed encounters high significance effects, followed by feed rate and least tool offset upon output response.

The X-ray diffractometer test was employed to specifically determine the existence of intermetallic compounds (IMCs) Al-Cu generated within the AA6101-C11000 joints. At medium 40 mm/min, 1000 rpm, and -1.68 mm, the IMCs developed were Al_4Cu_9 and Al_1Cu_3 giving a high UTS value of about 142.69 MPa. Mathematical model was developed utilizing the Response Surface Method (RSM) to predict the output response. The RSM mathematical model developed for Al (AA6101)-Cu (C11000) FSW joints was 96.2% accurate and significant. The highest FSW of Al-Cu joint efficiency obtained was 82% compared with the ultimate tensile strength value of aluminium. The AA6101-C11000 joint prepared using the FSW method exhibited a low resistance of 0.3 $\mu\Omega$ which is lower than the base metals copper and aluminium. Electrical conductivity value of the friction stir welded Al-Cu joint closely resembled that of the base metal aluminium. AA6101-C11000 FSW joints was found to have very good electrical conductance hence this method can be adopted for electrical applications.

Keywords: Friction stir welding, AA601, C11000, OHNS steel tool, Taguchi analysis, RSM.

Publications:

1. **Kumar J.P.**, Raj A., Arul K. and Mohanavel V., "A literature review on friction stir welding of dissimilar materials," *Materials Today: Proceedings*, vol 74, no. 1, pp. 286-291, 2021. DOI.org/10.1016/j.matpr.2021.04.449.(Scopus, Q3)
2. **Kumar J.P.**, Raj A., Venkatraman A.R., Kulandaivel A., Prabhu G.A, Narendranathan S.K. and Ashok N., "Analysis of temperature distribution and mechanical properties of friction stir welding of Al-Cu joints using hardened H13 steel tools," *Advances in Materials Science and* Engineering, vol. 2022, pp. 1-14, 2022. DOI.org/10.1155/2022/4973839.(Scopus, Q2)
3. **Kumar J.P.**, Raj A., Kulandaivel A., Kumar L., Mohanavel V., Ravichandran M., Rout I.S. and Prasath S., "Experimental analysis and RSM-based optimization of friction stir welding joints made of the alloys AA6101 and C11000," *Materials Research Express*, vol. 10, no. 5, pp. 1-23, 2023. **DOI**.org/10.1088/2053-1591/acd23d. (Scopus, Q2)
4. **Kumar J.P.**, Raj A., Ramesha K. and Rout I.S., "Design and optimization of friction stir welding of Al-Cu butt joint configuration using Taguchi method," *Journal of Mines, Metals and Fuels*, vol. 70, no. 8A, pp. 471-479, 2022. DOI.org/10.18311/jmmf/2022/32029. (Scopus, Q4)