Research on Optimal Design of Tool Probe for Friction Stir Welding

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ABSTRACT

Easily it will have problem between the tool probe of friction stir welding and welding parameter, leading to the affection, depending on the quality of tool life and friction stir welding nugget. The reason of this simulated experiment shows that this research is on optimal design of tool probe for friction stir welding. AZ61 Magnesium alloy and the AZ80 Magnesium are used as first priority of searching material in this experiment, which can let us get the thought of the tool probe design and the influence of friction stir welding on materials Observing the tool probe, which surface change, weight change, and adhesion force character are regarded as design considerations in search of the best design of tool probe and improving tool life is needed. In this experiment, basically there are cylindrical shape, taper shape, screw shape with different materials Besides it may have affection based on rotation speed, feed rate, tool tilt angle, and the parameter of Friction Stir Welding. Furthermore, it will have the differences compared with magnesium alloy. The comparison between friction stir welding and tradition weld has different viewpoints, even through there is obvious improvement after finishing welding process, still has some drawbacks. Moreover the reason why it will have this result depending on he hole in the organization of weld nugget and the post-weld heat treatment [PWHT]. After this process, there will be material losses after stirring, which means experiment sample also has this issue. From this research, we find there is a big connection among stirring material loss, weld drawback, and mechanical character. In addition, and the material loss comes from the stuff stuck on the tool probe, sample Fur side spillage, and the Fur Weight Disappearance under the Friction Stir Welding process. In the whole Study, we can find out the best design decision is screw probe in stirring procedure。

Keywords : Friction Stir Welding, Tool, Magnesium alloy

Table of Contents

REFERENCES

[1] WM. Thomas, ED. Nicholas, JC. Needham, MG. Murch, P. Templesmith, CJ. Dawes, GB Patent Application No 9125978.8,U.S.Patent No.5360317,Oct. (1995) [2] M. Guerraa,C. Schmidta,J.C. McClurea,L.E. Murra,A.C. Nunesb, ” Flowpatterns during Friction stir welding ”,Materials Characterization 49.pp.95-101. (2003) [3] J. Goni, P. Egizabal, J. Coleto, I. Mitxelena, I. Leunda, J.R. Guridi, High performance automotive and railway components made from novel competitive aluminum composites, Mater Sci Technol,19,pp.930 – 934.(2003) [4] A. Urena, M.D. Escalera, L. Gil, Influence of interface reactions on fracture mechanisms in TIG arc-welded aluminum matrix composites,Compos. Sci. Technol,60,pp.613 – 622.(2000) [5] R.Y. Huang, S.C. Chen, J.C. Huang, Electron and laser beam welding of high strain rate superplastic Al-6061/SiC composites, Metall. Mater. Trans. A 32A ,pp.2575 – 2584.(2001) [6] H.M. Wang, Y.L. Chen, L.G. Yu, ‘ In-situ ’ weld-alloying/laser beam welding of SiCp/6061Al MMC, Mater. Sci. Eng. A 293,pp.1 – 6.(2000) [7] X.P. Zhang, G.F. Quan, W. Wei, Preliminary investigation on joining performance of SiCp-reinforced aluminum metal matrix composite (Al/SiCp – MMC) by vacuum brazing,

Composites Part A30,pp.823-827(1999) [8] X.P. Zhang, L. Ye, Y.W. Mai, G.F. Quan, W. Wei, Investigation on diffusion bonding characteristics of SiC particulate reinforced aluminum metal matrix composites (Al/SiCp – MMC), Composites Part A 30 ,pp.1415 – 1421.(1999) [9] A. Urena, J.M.G. Salazar, M.D. Escalera, W.B. Hanson, Diffusion bonding of alumina reinforced 6061 alloy metal matrix composites using Al – Li interlayer, Mater. Sci. Technol. 16 ,pp.103 – 109.(2000) [10] J.R. Askew, J.F. Wilde, T.I. Khan, Transient liquid phase bonding of 2124 aluminum metal matrix composite, Mater. Sci. Technol. 14 ,pp.920 – 924.(1998) [11] W.M. Thomas, E.D. Nicholas, J.C. Needham, M.G. Murch, P. Temple-Smith, C.J. Dawes, International patent application PCT/GB92/02203 and GB patent application 9125978.8, UK Patent Office, London, December 6, (1991) [12] K. Nakata, S. Inoki, Y. Nakano, M. Ushio, Friction stir welding of Al2O3 particulate 6061 Al alloy composite, Mater. Sci. Forum 426 (4) ,pp.2873 – 2878.(2003) [13] T.W. Nelson, H. Zhang, T. Haynes, Friction Stir Welding of Aluminum MMC 6061 – Boron Carbide, Proceedings of the Second International Symposium on Friction Stir Welding, Gothenburg, Sweden, 26 – 28 June,Paper No. S08 – P3, (2000) [14] S. Packer, T.W. Nelson, C. Sorensen, Tool and Equipment Requirements for Friction Stir Welding Ferrous and Other High Melting Temperature Alloys, Proceedings of the Third International Symposium on Friction Stir Welding, Kobe, Japan, 27 – 28 September, Paper No. S5 – P3,(2000) [15] L.E.Murr and J.C.McClure, " Solid-State flow visualization in the friction stir welding of 2024 Al to 6061 Al " Scriota Materialia,Vol.40, No9, pp.1041 – 1046.(1999) [16] C.J. Dawes, E.J.R Spurgin and D.G. Staines, " Fiction Stir Welding Aluminium Alloy 5083-Incteased Welding Speed " ,Aug,TWI Report,(1999) [17] W.M.Thomas,E.D.Nicholas,J.C.Needham,M.C.Murch, P.Temple-Smith and C.J.Dawes(TWI), " Improvements Relating to Ftictino Welding " ,European Patent Specification 0615480 B1 [18] W M Thomas,P L Thteadgill and E D Nicholas, " The feasibility of friction stir welding steel " ,Slightly modified version published in Science and Technology of Welding and Joining,Vol.4,NO.6,pp.365 – 372.(1999) [19] M.W Mahoney,C.G.. Thodes, J.C.Flintoff, R.A.Spurling,W.H.Bingel,Matall. " Properties of Friction-Stir-Welded 7050 T651 Aluminum " ,Mater Trans 29A ,(1998) [20] GR Bradley,MN James, " Geometry and Mictostructure of Metal Inert Gas and Fiction Stir Welded AL Alloy 5383 – H321 " ,October (2000) [21] Y.J. Kwon, I. Shigematsu, N. Saito, " Mechanical properties of fine-graned aluminum alloy produced by friction stir process " , Scriota Materialia 49, pp.785 – 789.(2003) [22] M. Peel, A. Steuwer, M. Preuss, P.J. Withers, " Microstructere. Mechanical properties and residual stresses as a function of welding speed in aluminium AA5083 friction stir welds " ,Acta Materialia 51,pp.4791 – 4801.(2003) [23] K.N.Krishnan, " On the formation of onion rings in friction stir welds " , Materials Science and Engineering,A327,pp.246 – 251.(2002) [24] K.V. Jata and S.L. Semiatin, " Continuous dynamic recrystallization during friction stir welding of high strenght aluminum alloys " ,Scriota mater 43, pp.743 – 749.(2000) [25] J.Q.Su,T.W.Nelson,R.Mishra,M.Mahoney, " Microstructural investigation of friction stir welded 7050-T651 aluminium " ,Acta Materialia51,pp.713 – 729, (2003) [26] Y.J.Kwon,(AIST,Inst.for Structural and Eng,Mat.); N. Saito; I. Shigematsu, Journal of Materials Science Letter 21, Oct 1,pp.1473 – 1476.(2002) [27] G. Bussu , P.E. Irving " The role of residual stress and heat affected zone properties on fatigue crack propagation in friction stir welded 2024-T351 aluminium joints " International Journal of Fatigue,25, pp.77 – 88.(2003) [28] Jiayi Sun, Lijun Weng and Qunji Xue " Duplex treatment for surface improvement of 2024 Al " Vacuum,62,pp.337 – 343.(2001) [29] Manish Narayan, M. K. Surappa and B. N. Pramila Bai " Dry sliding wear of Al alloy 2024-Al2O3 particle metal matrix composites " ,Wear ,pp.181 – 183, pp.563 – 570.(1995) [30] N. E. Bekheeta, R. M. Gadelrabb, M. F. Salahc and A. N. Abd El-Azimc " The effects of aging on the hardness and fatigue behavior of 2024 Al alloy_SiC composites " Materials Science and Engineering ,pp.153 – 159.(2002) [31] Mingwu Bai, Qunji Xue, Xiue Wang, Yong Wan and Weiming Liu " Wear mechanism of Sic whisker-reinforced 2024 aluminum alloy matrix composites in oscillating sliding wear tests " Wear,pp.100 – 105.(1996) [32] Michael A. Sutton, Anthony P. Reynolds, Bangcheng Yang and Robert Taylor " Mode I fracture and microstructure for 2024-T3 friction stir welds " Materials Science and Engineering A354,pp.6 – 16.(2003) [33] M. J. Jones , P. Heurtier, C. Desrayaud, F. Montheillet, D. Allehaux and J. H. Driver " Correlation between microstructure and microhardness in a friction stir welded 2024 aluminium alloy " Scriota Mattrialia 52 ,pp.693 – 697.(2005) [34] Ying Li, L. E. Murr and J. C. McClure " Solid- state flow visualization in the friction stir welding of 2024 Al to 6061 Al " Scripta Materialia Vol. 14 No. 9 ,pp.1041 – 1046.(1999) [35] C. Genevois, A. Deschamps and P. Vacher " Comparative study on local and global mechanical properties of 2024 T351, 2024 T6 and 5251 O friction stir welds " Materials Science and Engineering A415,pp.162 – 170.(2006) [36] M. Amirizad, A. H. Kokabi 1, M. Abbasi Gharacheh, R. Sarrafi, B. Shalchi and M. Azizieh " Evaluation of microstructure and mechanical properties in friction stir welded A356+15%SiCp cast composite " Materials Letters 60 ,pp.565 – 568.(2006) [37] G. J. Fernandez and L. E. Murr " Characterization of tool wear and weld optimization in the friction-stir welding of cast aluminum 359+20% SiC metal-matrix composite " Materials Science and Engineering 52,pp65 – 75. (2004) [38] H.J. Liu, J.C. Feng ,H. Fujii ,K. Nogi, " Wear characteristics of a WC – Co tool in friction stir welding of AC4AC30 vol%SiCp composite " International [30] N. E. Bekheeta, R. M. Gadelrabb, M. F. Salahc and A. N. Abd El-Azimc " The effects of aging on the hardness and fatigue behavior of 2024 Al alloy_SiC composites " Materials Science and Engineering ,pp.153 – 159.(2002) [31] Mingwu Bai, Qunji Xue, Xiue Wang, Yong Wan and Weiming Liu " Wear mechanism of Sic whisker-reinforced 2024 aluminum alloy matrix composites in oscillating sliding wear tests " Wear,pp.100 – 105.(1996) [32] Michael A. Sutton, Anthony P. Reynolds, Bangcheng Yang and Robert Taylor " Mode I fracture and microstructure for 2024-T3 friction stir welds " Materials Science and Engineering A354,pp.6 – 16.(2003) [33] M. J. Jones , P. Heurtier, C. Desrayaud, F. Montheillet, D. Allehaux and J. H. Driver " Correlation between microstructure and microhardness in a friction stir welded 2024 aluminium alloy " Scriota Mattrialia 52 , pp.693 – 697.(2005) [34] Ying Li, L. E. Murr and J. C. McClure " Solid- state flow visualization in the friction stir welding of 2024 Al to 6061 Al " Scripta Materialia Vol. 14 No. 9 ,pp.1041 – 1046.(1999) [35] C. Genevois, A. Deschamps and P. Vacher " Comparative study on local and global mechanical properties of 2024 T351, 2024 T6 and 5251 O friction stir welds " Materials Science and Engineering A415,pp.162 – 170.(2006) [36] M. Amirizad, A. H. Kokabi 1, M. Abbasi Gharacheh, R. Sarrafi, B. Shalchi

and M. Azizieh ” Evaluation of microstructure and mechanical properties in friction stir welded A356+15%SiCp cast composite ” Materials Letters 60 ,pp.565 – 568.(2006) [37] G. J. Fernandez and L. E. Murr ” Characterization of tool wear and weld optimization in the friction-stir welding of cast aluminum 359+20% SiC metal-matrix composite ” Materials Science and Engineering 52,pp65 – 75. (2004) [38] H.J. Liu, J.C. Feng ,H. Fujii ,K. Nogi, ” Wear characteristics of a WC – Co tool in friction stir welding of AC4AC30 vol%SiCp composite ” International [48] Moataz M. Attallah ,Hanadi G. Salem ” Friction stir welding parameters: a tool for controlling abnormal grain growth during subsequent heat treatment ” Materials Science and Engineering A 391 ,pp.51 – 59.(2005) [49] W.M. Zeng and H.L. Wu , J. Zhang ” Effect of tool wear on microstructure, mechanical properties and acoustic emission of friction stir welded 6061 Al alloy ” Acta Metall. Sin. (Engl. Lett.) Vol. 19 No. 1 ,pp.9 – 19.(2006) [50] R. A. Prado, L. E. Murr, D. J. Shindo and K. F. Soto ” Tool wear in the friction-stir welding of aluminum alloy 6061+20% Al2O3: a preliminary study ” Scripta Materialia 45 ,pp.75 – 80.(2001)