ELECTRON BEAM WELDING OF AUTOGENOUS BUTT-JOINTS FOR AA5083-O ALUMINUM–MAGNESIUM ALLOY SHEET

E. Hazan[1], D. Ashkenazi[2], A. Stern[3,4]

[1]Nuclear Research Center - Negev, P.O. Box 9001, Beer Sheva 84190, Israel
[2]Tel Aviv University, School of Mechanical Engineering, Tel Aviv 6997801, Israel
[3]Department of Mechanical Engineering, Afeka Academic College of Engineering, Tel Aviv, 6910701, Israel
[4]Department of Materials Engineering, Ben-Gurion University of the Negev, Beer Sheva 8410501, Israel
*Corresponding author's e-mail address: dana@eng.tau.ac.il

ABSTRACT

Electron beam welding (EBW) is increasingly being used in welding structural metals. The thermal cycles associated with EBW are generally much faster than those involved in conventional arc welding processes, leading to a rather small fusion zone. Complete information on the tensile properties is essential for understanding the joint performance in service. Therefore, experimental investigation was performed on the mechanical properties of EBW welded AA5083-O sheets, using flat tensile specimens. An autogenous single electron beam pass was used to weld butt joints and butt joints with integral backup. The specimens were examined by visual testing, metallography light microscopy, microindentation hardness measurements and a tensile test. The results of the welded tensile specimens were compared to base metal (BM) specimens machined from the as-received materials. The yield stress of the welded samples is higher and the elongation is lower than the BM. An insignificant narrow heat affected zone (HAZ) was observed. The dendritic microstructure of the fusion zone (FZ) was relatively homogenous and the BM microstructure showed preferred orientation. Slightly higher microhardness values were observed in the FZ and HAZ than in the BM.

KEYWORDS: Electron Beam Welding, Al-Mg alloy, metallography, microstructure, mechanical properties

REFERENCES

[1] **Kah P., Suoranta R., Martikainen J.,** *Joining of sheet metals using different welding processes*, Mechanika, 2011, pp. 158-163.
[2] **Mathers G.,** *The welding of aluminium and its alloys*, Woodhead publishing, 2002.
[3] **Yang D., Li X., He D., Huang H., Zhang L.,** *Study on microstructure and mechanical properties of Al–Mg–Mn–Er alloy joints welded by TIG and laser beam*, Materials and Design 40 2012, pp. 117-123.
[4] **Shojaeefard M.H., Behnagh R.A., Akbari M., Givi M.K.B.**, **Farhani F.,** *Modelling and Pareto optimization of mechanical properties of friction stir welded AA7075/AA5083 butt joints using neural network and particle swarm algorithm*, Materials and Design 44, 2013, pp. 190-198.
[5] **Kou S.,** *Welding metallurgy*, 2nd Edition, *New York* (2002).
[6] **Çam G., Ventzke V., Dos Santos, J.F., Koçak M., Jennequin G., Gonthier-Maurin P.,** *Characterization of electron beam welded aluminum alloys*, Science and technology of welding and joining 4.5, 1999, pp. 317-323.
[7] **Zhao H., DebRoy T.,** *Weld metal composition change during conduction mode laser welding of aluminum alloy 5182*, Metallurgical and Materials Transactions 32.1, 2001, p.163.
[8] **Moraitis G.A., Labeas G.N.,** *Residual stress and distortion calculation of laser beam welding for aluminum lap joints*, Journal of materials processing technology 198.1, 2008, pp. 260-269.
[9] **Malarvizhi S., Raghukandan K., Viswanathan N.,** *Effect of post weld aging treatment on tensile properties of electron beam welded AA2219 aluminum alloy*, The International Journal of Advanced Manufacturing Technology 37.3, 2008, pp. 294-301.
[10] **Oliveira A.C., Siqueira R.H.M., Riva R., Lima M.S.F.,** *One-sided laser beam welding of autogenous T-joints for 6013-T4 aluminium alloy*, Materials & Design (1980-2015) 65, 2015, pp. 726-736.
[11] **Deschamps A., Ringeval S., Texier G. and Delfaut-Durut L.,** *Quantitative characterization of the microstructure of an electron-beam welded medium strength Al–Zn–Mg alloy*, Materials Science and Engineering: A 517.1, 2009, pp. 361-368.
[12] **Wanjara P. and Brochu M.,** *Characterization of electron beam welded AL2024*, Vacuum, *85*(2), 2010, pp.268-282.
[13] **Bardel D., Nelias D., Robin V., Pirling T., Boulnat X., Perez M.,** *Residual stresses induced by electron beam welding in a 6061 aluminum alloy*, Journal of Materials Processing Technology 235, 2016, pp. 1-12.
[14] **Alexopoulos N.D., Examilioti T.N., Stergiou V., Kourkoulis S.K.,** *Tensile mechanical performance of electron-beam welded joints from aluminum alloy (Al-Mg-Si) 6156*, Procedia Structural Integrity 2, 2016, pp. 3539-3545.
[15] **Nagai T., Kasai R., Ueno K., Mochizuki M., Suga T.,** *Effects of Metal Types on Residual Stress in Electron-Beam Welding Joints with*

Sheet Metals, ISIJ International 55.1, 2015, pp. 241-249.
[16] **Puydt Q., Flouriot S., Ringeval S., De Geuser F., Parry G., Deschamps A.,** *Relationship between microstructure, strength, and fracture in an Al-Zn-Mg electron beam weld: Part I: Microstructure characterization*, Metallurgical and Materials Transactions A 45.13, 2014, pp. 6129-6140.
[17] **Puydt Q., Flouriot S., Ringeval S., De Geuser F., Estevez R., Parry G., Deschamps A.,** *Relationship between microstructure, strength, and fracture in an Al-Zn-Mg electron beam weld: Part II: Mechanical characterization and modeling,* Metallurgical and Materials Transactions A 45.13 , 2014, pp. 6141-6152.
[18] **Zhan X., Chen J., Liu J., Wei Y., Zhou J., Meng Y.,** *Microstructure and magnesium burning loss behavior of AL6061 electron beam welding joints*, Materials and Design 99, 2016, pp. 449-458.
[19] **Hatch J.E.,** *Aluminum: Properties and physical metallurgy*, American Society for Metals, Metals Park, OH, 1984.
[20] **Jamshidi Aval H., Falahati Naghibi M.**, *Orbital friction stir lap welding in tubular parts of aluminium alloy AA5083*, Science and Technology of Welding and Joining 22.7 (2017), pp. 562-572.
[21] **Bray J.W.,** *Aluminum mill and engineered wrought products*, In: Properties and selection: Nonferrous alloys and special-purpose materials, Editor: R. Nunes, ASM International, (Volume 2), ASM Handbook 10th Ed., 1990.
[22] ******* *ASTM E8/E8M-13a. - Standard test methods for tension testing of metallic materials*, ASTM International, West Conshohocken, PA, 2013.

ISSN 1221-4639

Full paper: pp. 32-38