In the case of trail 1 the interface layer has not produced a good metallic bond between 316 stainless steel and AA1100 alloy. In the case of trail 4 and 8 the interface layer has produced a good metallic bond between aluminum and steel. A closer look at the penetration and sliding images shows that the failure of good bonding has taken place largely by interface separation (figure 14). One factor may be the uneven rate of heat generation. Due to this uneven rate of heat input, the amount of melt-off for each cycle for this welding combination of steel and aluminum varies. The other one is high hardness value of 316 stainless steel. During friction heating stage any surface irregularities are removed, the temperature increases in the vicinity of the welded surfaces, and an interface of visco-plastic aluminum is formed. During forging pressure stage there is significant thermo-plastic deformation of aluminum in the contact area. In result of this is formation of a flange-like flash. The process of welding takes place due to the plastic and diffusion effects.

Figure 15: Cut-section of friction welded AA1100 alloy and 316 stainless steel (a) weld joint with flash removed (b).

The optimal process parameters for AA1100 alloy and 316 stainless steel are found to be frictional pressure of 80 MPa, frictional time of 5 sec, rotational speed of 2000 rpm and forging pressure of 160 MPa. For these dissimilar metals of aluminium and steel, the forging pressure should be higher than the frictional pressure. The experimental fricitional welding validateds the the eightth trial conditions as shown in figure 15.

4. Conclusions

This study shows that the 316 stainless steel and AA1100 alloy is good if the operating conditions: frictional pressure of 80 MPa, frictional time of 5 sec, rotational speed of 2000 rpm and forging pressure of 160 MPa. For friction welding of AA1100 alloy and 316 stainless steel the forging pressure should be higher than the frictional pressure. For this condition of welding there was good penetration and sliding of materials at the welding interface resulting a good mechanical bonding.

5. Acknowledgements

The author acknowledges with thanks University Grants Commission (UGC) – New Delhi for sectioning R&D project.

References

[1] V. Srija and A. Chennakesava Reddy, "Finite Element Analysis of Friction Welding Process for 2024Al Alloy and UNS C23000 Brass," International Journal of Science and Research, 4 (5), pp. 1685-1690, 2015.
[2] T. Santhosh Kumar and A. Chennakesava Reddy, "Finite Element Analysis of Friction Welding Process for 2024Al Alloy and AISI 1021 Steel," International Journal of Science and Research, 4 (5), pp.1679-1684, 2015.
[3] A. Raviteja and A. Chennakesava Reddy, "Finite Element Analysis of Friction Welding Process for UNS C23000 Brass and AISI 1021 Steel," International Journal of Science and Research, 4 (5), pp. 1691-1696, 2015.
[4] J. Banker, A. Nobili, "Aluminum-Steel Electric Transition Joints, Effects of Temperature and Time upon Mechanical Properties, 131st Annual Meeting, Seatle, WA, USA, 2002.
[5] A. Chennakesava Reddy, "Evaluation of Parametric Significance in Friction Welding Process for AA7020 and Zr705 Alloy using Finite Element Analysis," International Journal of Emerging Technology and Advanced Engineering, 6 (2), pp. 40-46, 2016.
[6] A. Chennakesava Reddy, "Weldability of Friction Welding Process for AA2024 Alloy and SS304 Stainless Steel using Finite Element Analysis," International Journal of Engineering Research and Application, 6 (3), pp. 53-57, 2016.
[7] A. Chennakesava Reddy, "Fatigue Life Evaluation of Joint Designs for Friction Welding of Mild Steel and Austenite Stainless Steel," International Journal of Science and Research, 4 (2), pp. 1714-1719, 2015.
[8] A. Chennakesava Reddy, "Fatigue Life Prediction of Different Joint Designs for Friction Welding of 1050 Mild Steel and 1050 Aluminum," International Journal of Scientific & Engineering Research, 6 (4), pp. 408-412, 2015.
[9] A. Chennakesava Reddy, "Finite Element Analysis of Friction Welding Process for AA7020-T6 and Ti-6Al-4V Alloy: Experimental Validation," International Journal of Science and Research, 4 (8), pp. 947-952, 2015.
[10] A. Chennakesava Reddy, "Evaluation of parametric significance in friction welding process for AA2024 and Zr705 alloy using finite element analysis," International Journal of Engineering Research & Technology, 5 (1), pp. 84-89, 2016.
[11] A. Chennakesava Reddy, K. Ravaivarma, and E. Thirupathi Reddy, "A study on the effects of joint and edge preparation to produce cost reduction and distortion free welds," National Welding Seminar, IIT-Madras, 07-09th January, 2002, pp.51-55.
[12] S. Fukumoto, H. Tsubakino, K. Okita, M. Aritoshi, T. Tomita, "Amorphization by friction welding between 5052 aluminum alloy and 304 stainless steel," Scripta Materialia 42, pp. 807-812, 2000.
[13] A. Sluzalec, "Thermal effects in friction welding," International Journal of Mechanical Sciences, 32, pp. 467-478, 1990.
[14] A. Chennakesava Reddy, "Analysis of welding distortion in seam and skip arc weldings using finite element method," International Journal of Mechanical Engineering Research & Development, ISSN: 2248-9355, Vol.01, No.01, pp.12-18, 2011.
[15] Chennakesava, R. Alavala, "CAD/CAM: Concepts and Applications," PHI Learning Pvt. Ltd, 2008:
[16] Chennakesava R. Alavala, "Finite element methods: Basic Concepts and Applications, PHI Learning Pvt. Ltd., 2008.

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