ICCES, 2024, vol.31, no.2
DOI: 10.32604/icces.2024.012072

PROCEEDINGS

Hybrid Inverse Modeling Technique to Determine the Fracture Properties of Intermetallic Layer Formed at Al/Steel Dissimilar Weld Interface

Kiyoaki T. Suzuki[1,*], Sylvain Dancette[2], Shun Tokita[3] and Yutaka S. Sato[4]

[1]Department of Materials Processing, Graduate School of Engineering, Tohoku University, 6-6-02 Aramaki-aza-Aoba, Aoba-ku, Sendai 980-8579, Japan

[2]ELyTMaX IRL3757, CNRS, Univ Lyon, INSA Lyon, Centrale Lyon, Université Claude Bernard Lyon 1, Tohoku University, Sendai, 980-8577, Japan

[3]Department of Materials Processing, Graduate School of Engineering, Tohoku University, 6-6-02 Aramaki-aza-Aoba, Aoba-ku, Sendai 980-8579, Japan

[4]Department of Materials Processing, Graduate School of Engineering, Tohoku University, 6-6-02 Aramaki-aza-Aoba, Aoba-ku, Sendai 980-8579, Japan

[*]Corresponding Author: Kiyoaki T. Suzuki. Email: kiyoaki.suzuki.q1@tohoku.ac.jp

ABSTRACT

Dissimilar welding of aluminum (Al) alloy to steel has been a long-running scientific and technological problem mainly for the automotive industry. It would allow to achieve new designs of optimized vehicle structures combining strength, lightweight and energy absorption ability. However, the weld strength is limited because of a brittle intermetallic layer (IML) formed at the weld interface. In our previous study, we demonstrated a significant improvement in weld strength by the addition of Ni to aluminum alloy. However, the effect of Ni addition on the fracture properties of IML remains unexplored. Moreover, additional Ni should also affect the yield strength and deformability of Al alloy itself. Hence, in this study, a hybrid inverse modeling technique was used to determine the fracture properties of IML. Digital image correlation (DIC) was used to measure the displacement field across the sample surface during tensile shear tests. Finite element model (FEM) with a cohesive zone model (CZM) was used to model the fracture through the IML between Al and steel. Displacement filed experimentally measured by DIC was applied to the FEM to precisely determine the CZM parameters, i.e. interfacial strength and fracture energy of IML. This hybrid DIC-FEM inverse modeling technique was used to analyze different Al/steel welds with varying composition of Al alloys (A1050 and Al-Ni). From a wide range of tentative interfacial strength and fracture energy for the CZM, this study clarified that the interfacial strength of IML formed at Al-Ni/steel weld was higher than that of A1050/steel one without Ni addition.

KEYWORDS

Dissimilar welding; Al/steel welds; intermetallic layer; cohesive zone model; digital image correlation

Acknowledgement: The authors acknowledge the support from GP-MS at Tohoku University.

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.