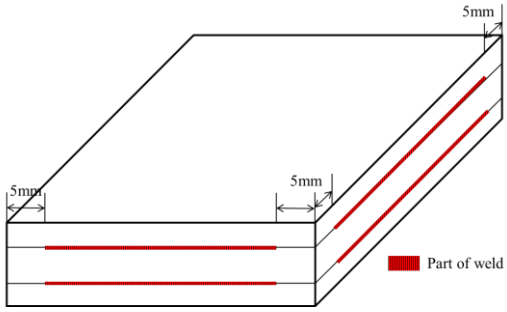
Study on the Applicability of Electron Beam Welding Methods to Assembly a Fuel Compact and Al Cover Plate of Research Reactor Plate Type Fuel

Hae-In Lee*, Yoon-Sang Lee, Don-Dae Lee, Yong-Jin Jeong, Sun-Chil Kwon, Soo-Sung Kim, Jong-Man Park

Research reactor fuel development division, korea atomic energy research institute 1045 daedeok – daero, yuseong – gu, daejeon, 305-353, republic of korea
**Corresponding author: lhi0802@kaeri.re.kr*

1. Introduction

Among the research reactor plate type fuel fabrication processes, there is an assembly process between fuel meat compact and Al cover plates using a welding method prior to rolling process. The assembly process is such as the Al frame and Al cover plate should be welded properly as shown in Fig. 1.



For welding, TIG(Tungsten Inert Gas) welding methods has been used conventionally, but in this study an electron beam welding(EB welding) technique which uses the electron beam of a high velocity for joining two materials is introduced to the assembly. The work pieces are melted as the kinetic energy of the electron beam is transformed into heat to join the two parts of the weld. The welding is often done in the conditions in a vacuum to prevent dispersion of the electron beam [1]. The electron beam welding process has many advantages such as contamination of the welds could be prevented, the penetration of the weld is deep, and also the strain of the welding area is less than other methods. In this study, to find optimal condition of the EB welding process, a welding speed, a beam current and an acceleration voltage were changed. To analyzing the welding results, the shape of the beads and defects of welding area was used. The width and depth of the beads were measured as well.

2. Experiment and Results

2.1 Welding conditions

The EB welding machine used to this experiment was TECHMETA, 3 kW and 60 kV. The cover plate and frame were made of Al 6061, whose dimension is 130 x 100 and t=6.5 mm. Welding conditions (The voltage, current and welding speed) were changed as shown in Table 1.

Table 1. Welding conditions

	Current (mA)	Voltage (kV)	Speed (F)
Condition 1	20	30 40 50 60	800
Condition 2	10 20 30 40	60	800
Condition 3	25	60	300 400 500 600

2.2 Results

In order to analyze the bead of specimen, the specimen was cut to observe the cross section of the welding area. The cross section area was polished and etched with 10g NaOH in 90 ml water at a room temperature.[2] The bead shape was observed with microscope in magnification ratio of 50 times. The width and depth of the bead were measured according to the welding conditions. The micrographs of the bead area of the cross section of the specimens are shown as in Fig. 2.

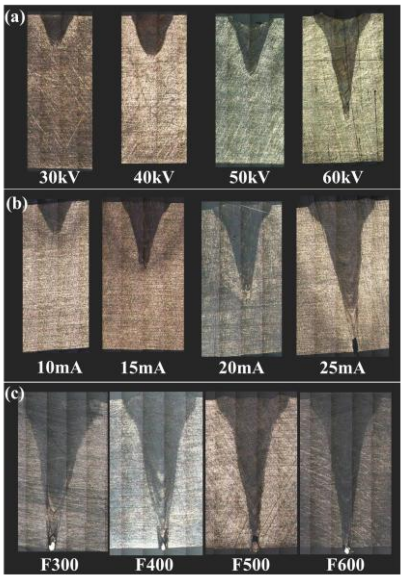
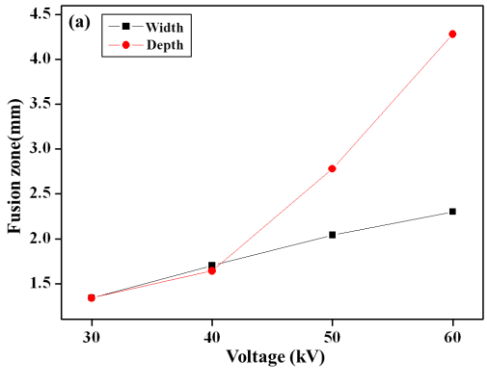
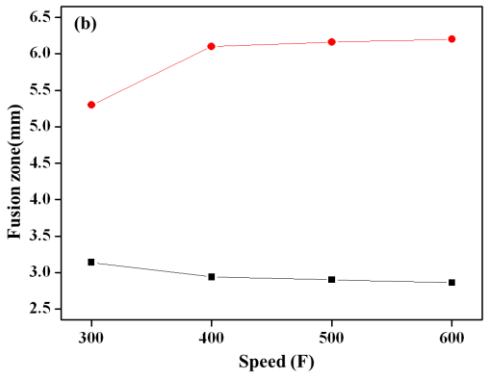


Fig 2. Optical micrographs showing the fusion zones observed in the sample(6061 Al) welded under (a) holding 20mA and 800F, changing Voltage, (b) holding 60kV and 800F, changing Current, (c) holding 25mA and 60kV, changing Speed.

Fig 3 shows the variations of the width and depth of the bead according to the weld conditions.





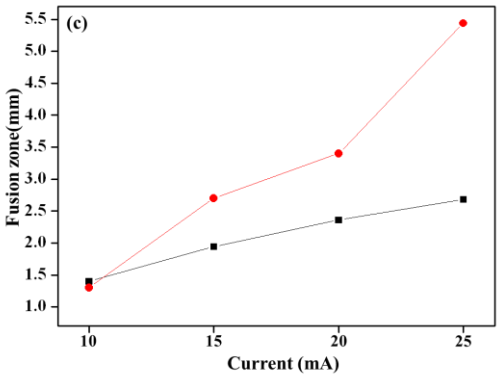


Fig 3. Variation of the fusion zone width and depth depends on conditions: increasing the (a) voltage, (b) speed and (c) current

The thickness of the cover and frame would be about 3mm and 5mm respectively. In order to be properly bonded btween cover and frame, the depth of bead should be over 5mm at least. According to this experiment, the optimum condition considered to be 25mA in current, F600 in beam speed and 60kV in voltage. In case of welding in a high speed, the shape of bead became more sharp than low speed and the width of bead became narrow.

3. Conclusions

In this study, the applicability of EB welding technique to the assembly welding was tried. to find optimal condition of the EB welding process, a welding speed, a beam current and an acceleration voltage were changed. The width and depth of bead was rised with increase of voltage and electric current. when beam speed increased, the width of bead narrowed and the shape of bead sharpened. The optimal condition is 25mA in current, F600 in beam speed and 60kV in voltage. The limitation of the welding conditions to obtain the desired depth for the assembly welding using EB welding method could be estimated.

REFERENCES

[1] Schultz and Helmut (1993) Electron Beam Welding, Cambridge and England: woodhead publishing/The Welding Institute ISBN 1-85573-052-2
[2] Kee Young Lee and Dept. of Metallurgical Engineering Graduate School and Chobuk National University