Development of a Chamber for the Pin-Hole Laser Welding

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1. Introduction

We have been studied about an irradiation test using a capsule for a fuel performance test in the test reactor. An irradiation fuel has a pin and it fill up with helium gas through a pin hole. After fill of helium gas, a pin hole should be sealed by welding. Therefore, the vacuum/pressure chamber is needed for seal welding and also, is needed the welding device. The method of normal seal welding is TIG spot in shot time and high current condition. But we developed the seal welding chamber using a fiber laser. This welding chamber will be used for the fabrication of LVDT(Linear Variable Differential Transformer) and instrumented irradiation fuel. This paper describes about the design of welding chamber, the fabrication of chamber and test of pin-hole welding.

2. Design of a Chamber for the Pin-Hole Laser Welding

We have a fiber welding system for the development of LVDT and irradiation test. Fig. 1 shows the 150W fiber welding system that consists of a welding head, monitoring vision system and rotary index. We designed a pin hole welding chamber using welding head of fiber laser. The design value of chamber is pressure of maximum 150 bar and vacuum of maximum 10^{-3} torr. We referenced the chamber of Norway Halden's pin hole welding but Halden's pin-hole welding is TIG spot welding. So, KAERI's pin-hole welding chamber is very different from that is using fiber laser. Laser beam passés the fused sillca window for Ø 1.0mm pin welding. Also, the chamber was designed can be extended the chamber length [1-3].

Fig. 1. Fiber Laser Welding System

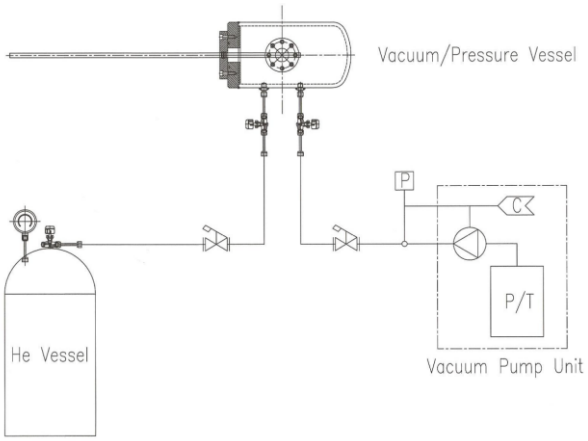

Fig. 2. Design of chamber for Pin-Hole Laser Welding

3. Fabrication of a Laser Chamber for the Pin-Hole Laser Welding

The chamber vessel is the high pressure of Max. 150 bar. So, fabricated chamber should be tested hydrostatic test to 14.7 MPa. The chamber has a helium gas line and a vacuum line. Helium gas line that connected to a helium gas bottle has two pressure valve and pressure gauge. Also vacuum line that connected to a vacuum pump has a vacuum gauge and a vacuum valve. A sample for pin-hole welding goes to the laser window by the guide screw. The right position of a sample can be control by welding head's reposition.

Fig. 3. Chamber for Pin-Hole Welding

4. Performance Test of Pin-Hole Welding

We had tested pin-hole welding according to the procedure. The chamber's vacuum value is below $5x10^{-2}$ torr. If vacuum gauge's value is reached below $5x10^{-2}$ torr, the vacuum valve is closed and helium gas is supplied to referenced value. Test pressure is 25 bar in

this test. Spot length from laser head is 137mm. Fig. 4 is picture before and after of pin-hole welding. Spot numbers are 4 times around Ø1.0mm pin and pulse widths are 10ms (peak power=1.5kw) and 20ms (peak power=0.75kw). Fig. 5 is optical micrographs of pin-hole welding. The pin-hole welding of 20ms pulse width has wider bead than 10ms pulse width but welding depth is a little narrow. Welding depth is 0.2-0.3mm and if increase spot numbers, welding depth will be increased.

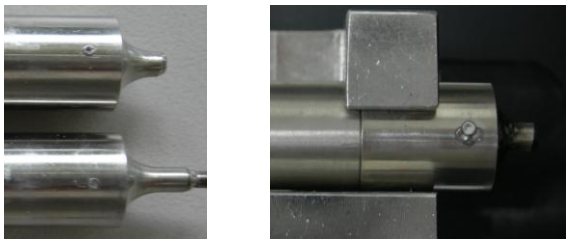

Fig. 4. Pin-hole Weldings (Before, After)

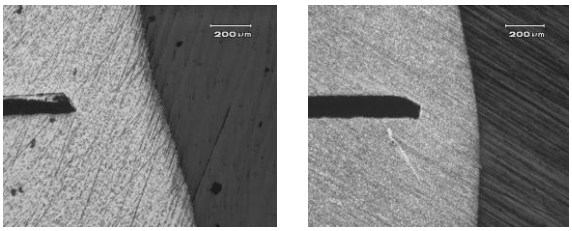

Fig. 5. Optical Micrographs of Pin-hole Welding(Pulse width 10ms, 20ms)

5. Conclusion

The fiber laser chamber for pin-hole welding was developed. The chamber showed good performance in $5x10^{-2}$ torr pressure and 25 bar pressure. Also, the results of optical micrographs of pin-hole welding showed that pulse width of 10ms is enough for pin-hole sealing. But additional tests need for deeper welding. After final test, this welding chamber will be used for the fabrication of LVDT and instrumented irradiation fuel and will proceed to an irradiation test stage at the HANARO reactor later this year.

Acknowledgements

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