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New Method Real Time Inspection for Laser Welding Process

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Abstract:
In this paper, discussed about once methode of quality monitoring technology for the laser welding was conducted. The laser welding and the industrial robotic systems were used with robot-based laser welding systems. The laser system used in this study was 1.6kW fiber laser, while the robot system was Industrial robot (payload : 130kg). The robot-based laser welding system was equipped with a laser scanner system for remote laser welding. The welding joints of steel plate and steel plate coated with zinc were butt and lapped joints. The remote laser welding system with laser scanner system is used to increase the processing speed and to improve the efficiency of processes. The welding joints of steel plate and steel plate coated with zinc were butt and lapped joints. The quality testing of the laser welding was conducted by observing the shape of the beads on the plate and the cross-section of the welded parts, analyzing the results of mechanical tension test, and monitoring the plasma intensity by using UV and IR sensor.

Keywords: *Inspection, UV, IR, Laser, Welding*

1. Introduction

Laser welding is one of the critical technologies used in the manufacturing of lighter, safer automotive bodies at a high level of productivity; to that end, the leading automotive manufacturers have replaced spot welding with laser welding in the process of car body assembly. Korean auto manufacturers are developing and applying the laser welding technology using a high output power Nd:YAG laser and a 6-axes robot [i,ii]. The conventional spot resistance welding used in the car body assembly process has been an obstacle to car design and manufacturing due to the limited applicability and lower welding efficiency resulting from the geometry and welding characteristics of spot welding machines. As such, the automotive industry has been trying to develop new welding and joining technologies [iii-v]. This study was conducted to develop a remote car body laser welding technology, a welding quality inspection technique, and a robot control. In particular, due to the characteristics of laser welding - where the laser beams have to be directed perpendicularly to the welding surface - it is very difficult to instruct the robot to direct the laser beam perpendicularly on to a curved surface. Indeed, many studies have been performed to improve the speed of the robot laser welding process and the quality of welding parts [vi,vii]. In this study, these problems were addressed by applying the remote laser welding method and the quality monitoring method.

2. Experimental Equipments

The laser welding can achieve by manipulating the axes of the robot system. The laser generator used was 1.6kW fibre laser system, and the robot system was the six axes Industrial robot of payload 130kg. To conduct a basic study of the weldability of the remote laser welding system, butt welding and lap welding were carried out with simple steel plates and galvanised plates. The beam from the laser generator is transmitted via an optical fibre to the welding head at the end of the robot's arm. The weld joints were inspected and tested for tensile strength to determine the optimal welding parameters. To devise a technique for measuring the quality of the laser welding on a real-time basis, basic experiments conducted with a method capable of determining the quality of welding by monitoring plasma and temperature. Pattern welding tests were conducted to examine the accuracy of the entire remote laser welding system. Figure 1 the developed regime of the whole remote laser welding control system.

Figure 1: The robot-based remote laser welding system

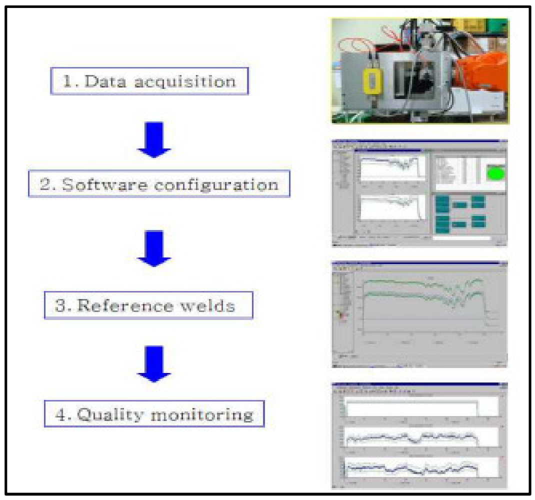

Figure 2: Process sequence of quality monitoring system

3. Test Results

During laser welding on a real-time-basis, necessary tests were conducted to develop a technique which facilitates the evaluation of weld quality by monitoring plasma and temperature. Tests were performed using an Nd :YAG laser and a fiber laser. To monitor weld quality using plasma flux intensity, the initial criteria of plasma power - which itself determines the critical weld quality - needs to be established. When the plasma power lies between the maximum and minimum values of the standard range as Figure 3, the weld quality can be judged to be acceptable

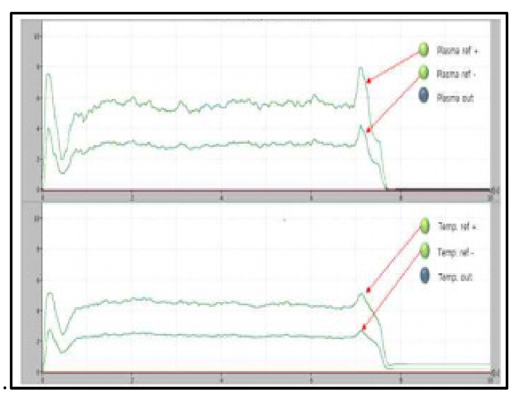

Figure 3: The result of quality welding

Figure 4 shows the results of plasma monitoring test. In the Nd:YAG laser tests, stainless steel specimens were welded at laser powers of 3kW. One UV-type and two IR-type sensors were used in the tests conducted to detect plasma intensity. Three holes measuring 2mm in diameter were machined into steel sheets to test whether it was possible to identify defective parts in which no plasma could be generated due to potential defects in the machining. In addition, steel wire measuring 2mm in diameter was attached to the steel sheets - perpendicular to the welding direction - to test whether changes in the generation of plasma caused by changes in the laser's focal length could be detected. The applied welding conditions were laser power of 3kW and a welding speed of 3m/min.

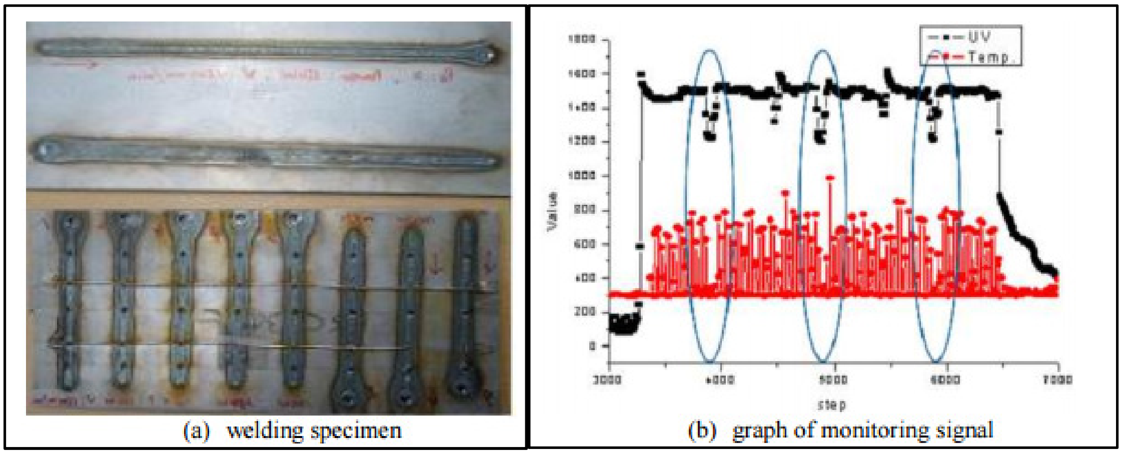

Figure 4: The results of plasma intensity detection using an Nd:YAG laser

Figure 5 shows the results of the welding test for optimal welding conditions using a fiber laser. Figure 6, Figure 7 and Figure 8 show the test results of the welding quality monitoring using a fiber laser on the basis of the test results of the Nd:YAG laser. The fiber laser was tested at from 400W to 1,600W power using UV and IR sensors. The results were obtained by scanning the steel sheet many times with the laser scanner of the remote laser welding system. The plasma and temperature signals could be detected at the appropriate values, confirming that real-time-based quality monitoring can be implemented.

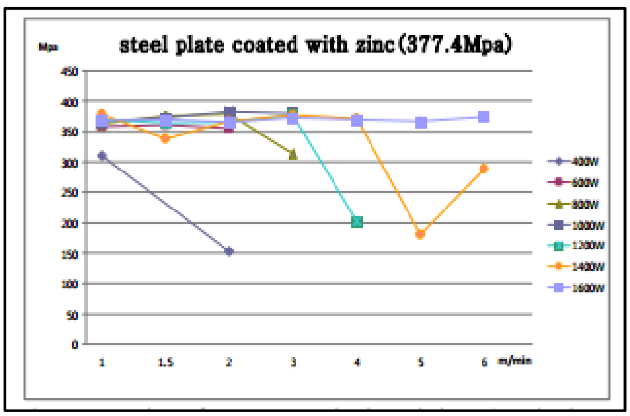

Figure 5: Results of UTM test in butt joints (steel platecoated with zinc)

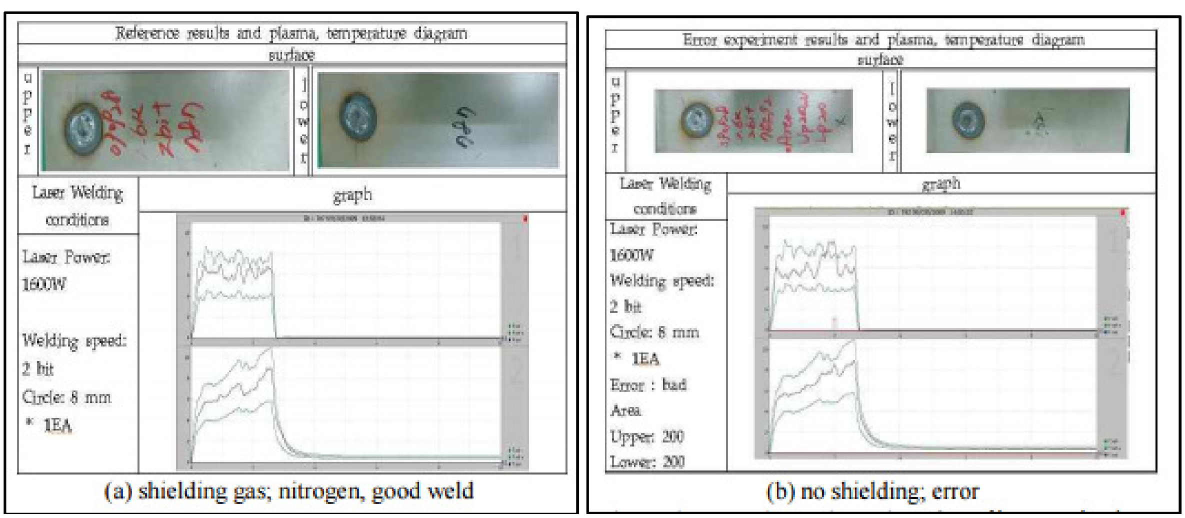

Figure 6: The experimental results of quality monitoring during remote laser welding for a circle pattern

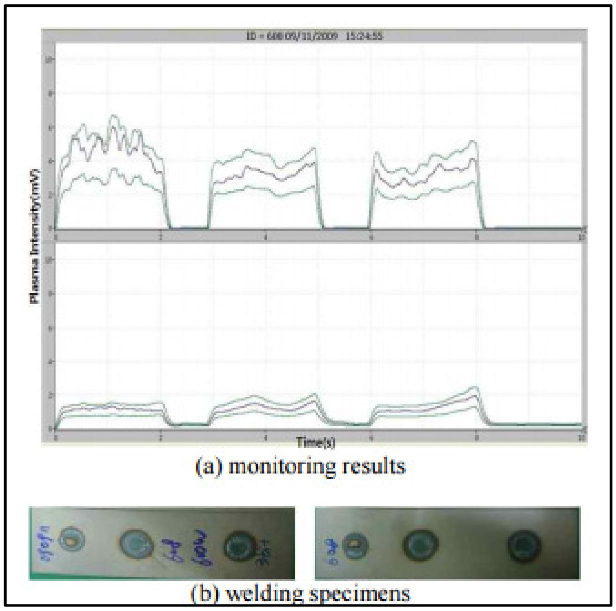

Figure 7: Results of quality monitoring during remote laser welding for three circle patterns

4. Conclusion

The remote laser welding robot system was built on the basis of the interfacing between the laser system and the industrial robot system. Using the remote laser welding system, butt and lap welding of common and galvanized steel sheets were conducted and the tensile strength of the samples was tested to determine the optimal welding parameters. The remote laser pattern welding tests were conducted and the weld joints and defects were analyzed. During the laser welding, the plasma intensity signals were measured and analyzed to assist the development of a technique which enables evaluation of the quality of laser welding in real time. On the basis of the remote laser welding quality tests, the lap welding of galvanized steel sheets and the algorithms for evaluating the quality of laser welding will be tested in further studies.

5. Acknowledgment

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