TEMPERATURE DISTRIBUTION IN FRICTION SURFACING OF SUS304 PLATE WITH SUS304 ROD

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1. Introduction
Friction surfacing is a solid state technique and taking wide application in surface engineering to lay high strength, wear- and corrosion-resistant coating. Heat, caused by appropriate friction of contact surfaces, plasticize the consumable rod. Part of plasticized material forms rotating plane and is deposited on the substrate by pressing the rod down and traversing the substrate or the rod perpendicular to the rod axis [1]. Friction force is not equally distributed along the contact surface. Obviously, temperature is also not similar along the radius of contact surface. Although effect of rotational speed on heat input rate was explained [2] and temperature field and heat flow during the process were simulated [3], it is necessary to measure temperature distribution and heat input during the process.

In this study, temperature distribution inside the consumable rod and the substrate surface were investigated.

2. Experimental
Friction surfacing experiments on SUS304 substrates were conducted - Ø10 mm SUS304 rods were used to make coatings on the substrates.

3-axis Enshu S400 vertical machining center without load control was used in the experiments. Pressure on the tip of the consumable rod was controlled by changing the feeding rate of the rod. Substrate was gripped in a vice with backing plate. Three K type thermocouples were placed under the substrate to measure temperature in advancing side (AS), center part (CP) and retreating side (RS) of coating. Thermocouples for AS and RS sides were 4 mm away from the one for CP. Their tips were exposed on the surface and brought to the same level by filing. One or two couples of K type thermocouple were mounted to the rod. Inserted tips of thermocouples laid in the rotation axis (RCP – Rod Center Point) or 2.5 mm away from it (ROS – Rod Outer Side), and 30 mm above from the rod’s bottom end. Data from the rod’s thermocouple was received via telemetric device. Thermocouples were inspected before and after mounting to substrate and rod, and after experiment.

Fig. 1 Illustration of friction surfacing process.
At preheating, consumable rod was rotated and fed in two stages with different rates. After reaching necessary heat, it was traversed along the substrate. Feeding rate during traverse was different from ones in preheating. Force on the tip of the rod was measured with dynamometer. During coating at process parameters with 2000 rpm, 70 mm/min feeding speed and 300 mm/min traverse speed, force was 3.5 kN in feeding direction.

3. Results and Discussion

Figure 2 shows the coating with 2000 rpm, 70 mm/min feeding rate and 300 mm/min traverse speed. The temperature of AS was the highest and temperature of RS was the lowest. When traverse speed decreased to 280 mm/min, temperature of AS was lower than temperature of CP. Figure 3 shows the temperatures obtained at those process parameters. The temperature inside the rod was higher than temperature on the substrate under rotating plane. In general, when traverse speeds decreased at the same rotation speeds and feeding rates, temperature of the rod was not changed significantly despite force increased from 3 kN to 3.5 kN or from 3.5 kN to 5 kN.

When feeding rate decreased from 70 mm/min to 65 mm/min at 1800 rpm and 280 mm/min traverse rate, temperature of AS, CP and RS decreased. It resulted from decreasing of feeding force for 1 kN and temperature inside the rod.

Obtained results were as following: a) high traverse speed at the same rotation speed and feeding rate of the rod may provide the highest temperature at AS; b) temperature at RS is the lowest in all cases and that is caused by relatively low friction force at RS; c) temperature of the rod at 2.5 mm away from rotation axis was same with or higher than that at the rotation axis of the rod at the same process parameters; d) decrease in feeding rate of the rod caused decrease in temperatures of AS and CP of the substrate, and inside the rod; e) change in traverse speed didn’t cause significant change in temperature of the rod; f) temperature inside the rod was higher than temperature on the substrate under rotating plane.

4. Conclusion

Direct measurement of temperatures inside the rod and under coating on the substrate with inserted thermocouples was succeeded at different parameters. Temperature field of rotating plane at comparatively narrow process window was observed.

References