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Abstract
This study investigates of 3-mm Inconet 690 alloy plate welding characteristics including welded shape, subgrain structure, penetration depth, penetration depth/width ratio and porosity ratio. To achieve this goal, a 2.5 kW Nd:YAG laser was employed with a rectangular wave shape and varied with ΔP (ΔP＝Pp－Pb， Pp：peak power； Pb：base power) gradually reduced to zero under an identical mean power (1.5 kW), namely from a PW (pulse wave) to CW (continuous wave). Experiments were conducted under different welding speed (1500, 1800, 2100 mm/min) in three kinds of shielding gas (Ar, He and N2) , with varying flow rate (10, 16, 22 l/min).

The study result indicates that penetration depth (PD), and penetration depth/width ratio (PDWR) increases with ΔP increases. Similarly, the extent of the roughness of weld surface (RWS) and the molten melt spattering (MMS) increases with ΔP increases as well. However, different shielding gases and their varying flow rates did not cause obvious changes in PD, PDWR, RWS and MMS. The result also shows that the extent of porosity ratio of weld differs greatly among shielding gases. The Ar and He have the most effect while N2 has the least. However, shielding gas flow rates did not play an important role on the porosity ratio changes. The plasma plume varied, depending on the ionization of shielding gases. Ar produced the most plasma plume while N2 is the second and the He is the least. As far as the flow rate goes, the plasma plume changes reversely with the gas flow rate. Plasma plume also increases with the ΔP increases. Besides, when compared under the same flow rate, Ar caused the largest blowing angle changes while N2 caused the second and He almost did not cause no changes. The next observation is the solidification crack of weld. The shielding gas He caused the most frequent cracks while Ar is the second and N2 caused crack is almost non-existent. According to the observation, cracks usually occurred at where porosities exist. There are two possible cracking locations. The first is along the poprosity wall while the second is at the interface of porosity wall and the weld. Micro-porosities of weld almost always occurred at the macro-porosity wall no matter what shielding gas was used for the experiment. They are distributed among interdendritic spaces. The shielding gas He produced the most frequent micro-porosities while N2 produced the least. There are similar structures among all subgrain structures formed around welds. They are cellular structure along fusion lines and cellular dendritic structure along welds. The most common subgrain structure, columnar dendrite and equiaxed dendrite, during GMAW and SMAW welding operations were not observed. Further observation also shows that different welding parameters did not cause obvious differences among grain sizes and interdendritic

spaces. The heat affection zone also did not exist near fusion lines.
Advisory Committee T.Y. Kuo - advisor

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