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Abstract
This research uses a high power Nd：YAG laser to perform bead-on-plate (BOP) welding on Inconel 690 alloy plates of thickness 3 mm with continuous wave(CW) under three different output of power (1000 W, 1250 W, 1500 W) and with pulse wave (PW) under three different frequencies (100 Hz, 200 Hz, 300 Hz) combining with independence of four different laser incident angles (± 20U+2DA，±10U+2DA) and applying with Ar, He, N2 as shielding in the same flow rate and angle of nozzle. The influences of plasma volume, welding morphology, penetration depth, depth-to-width ratio and porosity formation were investigated.

The results show that the types of shielding gas have significant effect on the plasma volume of the welding. The welding formed under Ar shielding the greatest plasma, while that formed under He shielding has the lowest. Under Ar and N2 shielding, the blow-away plasma is quite more obvious. There is no appreciable change in the blow-away plasma for He due to its lower mass. The plasma volume of PW with average power was larger than CW. On the situation of welding spattering, the positive angle of the laser beam and the lower of pulse frequency can decrease the degree of welding spattering. The influences of power and the shielding gas were not obvious for welding spattering. In addition, the penetration and depth-to-width ratio would increase as power increased or the same average power of PW was used. According to porosity formation, the choice of shielding gas has significant effect on the porosity ratio of the welding. That formed under shielding gas, N2 is not apparently changeable in other different parameters. While Ar and He as shielding, the porosity produces less under PW than CW and the diameter of porosity is bigger than CW. The influences of porosity for laser incident angles were different types of shield gas.
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