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Effects of ambient pressure on single-pulse laser processing of austenite stainless steel

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Abstract: The effects of ambient pressure on single-pulse laser processing of austenite stainless steel were investigated in this study. The ambient pressure environments were created by Ar gas and ranged from 0.001 bar to 45 bar. It is observed that the ejection and expansion of the metal vapor are severe under a low pressure and gradually become limited with the increase of ambient pressure. Numerous oxides remain on the molten-pool surface under a low pressure, and a shiny solidified molten-pool surface without oxides can be obtained when the pressure is higher than 10 bar. Furthermore, the ripples induced by the ejection of the metal vapor were detected on the solidified molten-pool surface, and it significantly reduced with the increase in ambient pressure. Larger aspect ratios of molten pools were obtained under higher pressures, and a tendency wherein the primary dendrite arm spacing and grain size decrease with the increase of ambient pressure was observed. When the ambient pressure changed from 0.001 bar to 45 bar, the aspect ratio increased by approximately 12%, the dendrite arm spacing decreased approximately 12% and 4% on the side and center positions, respectively, and the grain size decreased approximately 37%.

Keywords: Ambient pressure; Single-pulse laser processing; Plasma plume; Surface appearance; Microstructure; Austenite stainless steel