Laser Weldability of Additively Manufactured Aluminum Alloys: Insights into Welding Conditions and AM Techniques

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Metal additive manufacturing (AM) has demonstrated considerable benefits over conventional subtractive machining techniques, such as improved design flexibility, enhanced material efficiency, and shorter lead times. Over the years, significant research has focused on material design and process development, aiming for higher mechanical performance. However, the weldability of AM components has been less investigated, despite being a crucial factor for the successful integration of AM and traditionally manufactured components. Additionally, welding AM components presents an opportunity to overcome the dimensional limitations of powder-based AM techniques, a longstanding challenge.

In this presentation, we will address key challenges in the laser welding of additive-manufactured materials through a series of case studies. First, the impact of various welding conditions on the weld quality of aluminum alloys produced by laser powder bed fusion (LPBF) will be justified. These include welding configurations, the use of filler material, pre-welding surface treatments, laser wobbling, and static beam shaping. Next, we will present a benchmark comparison of the laser weldability of aluminum alloys produced by conventional extrusion, LPBF, and Molten Metal Deposition (MMD), a new metal AM technology that uses affordable wire feedstock and eliminates the need for a high-power laser source. Finally, we will explore opportunities for improving the weldability of AM components from both the printing and welding perspectives.