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Editorial

New Frontiers of Laser Welding Technology

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With the advances in power sources and optic technologies, high-power laser welding has been utilized in many applications such as automotive, battery manufacturing, and electronic industries. The low-heat input of laser power and its precise control enables minimal thermal damage and geometric inaccuracy in the weldment. Recently, laser welding has evolved in combination with machine learning, monitoring and control technology, new materials, and new processes.

This Special Issue aims to present the recent advances in the development in innovative laser welding technologies based on new laser power sources, laser optics, systems, and monitoring technologies. A total of six papers are presented in this Special Issue.

Lee et al. [1] suggested a methodology to quantify the contamination of coupling glass during vacuum laser welding. Vacuum laser welding is a combination of laser welding and a vacuum environment that results in a deeper penetration and enhanced stability compared with the conventional laser welding under the atmosphere. The developed contamination index was cited in successive studies [2–4] to optimize vacuum laser welding. Pang et al. [5] introduced laser beam oscillation on a 5056 aluminum alloy. Beam oscillation could improve the appearance and depress spatter formation. Moreover, a weld microstructure with a fine grain and uniform dendrite distribution was achieved by proper beam oscillation patterns. In the mechanical test, the elongation was significantly more enhanced than the linear laser welds. Kim et al. [6] proposed the equivalent strain method to predict the welding deformation of a large structure. In simulations to predict the welding deformation in a large welding structure, time-efficient analysis methods are necessary, and the inherent strain methods were suggested as the most suitable tool in their study. The developed method showed a much smaller analysis time than the thermal elastic–plastic analysis method and a more accurate analysis than the equivalent load method. Park et al. [7] demonstrated the effect of gravity on the weld pool and metallurgical behavior. In flat, overhead, and vertical down positions, high-speed photography and welding signal acquisition revealed that the direction of gravity influenced the droplet transfer, weld pool flow, and bead shapes, thus determining the microstructure and hardness profile. Maina et al. [8] invested the effect of surface shape and roughness on the laser welding of a copper alloy. Although copper laser welding has an important role in automotive and renewable energy industries, copper has a high thermal conductivity and low laser absorptivity, which causes unstable welds and spatter generation. They exhibited that concave holes and a surface roughness variation could stabilize copper laser welding, and an optimized surface texture could increase the weld penetration and surface quality. Gomes et al. [9] published a valuable review on the laser welding of vascular and nervous tissues in this Special Issue. They reviewed the process variables for the successful laser welding of vascular and nervous tissues. Strategies to avoid thermal damage and increase the bonding strength were introduced from the references.

Laser welding will continue to expand in high-power and high-precision application fields. In order to apply laser welding to new materials such as non-ferrous metals, non-

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metals, and organic materials, new laser power sources, laser optics, and processes will become new research topics for laser welding scientists and engineers.

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