

Laser Keyhole Welding of Steel

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Types of Lasers Used for this Application

1. Pulsed and continuous CO₂ laser.
2. Solid state lasers Nd:YAG - rod, Yb:YAG - disk and Yb:glass – fiber
3. High power diode lasers

Reasons for Use

1. Laser welding requires large power density.
2. These lasers offer a great opportunity to weld **fast** and **accurately** and to provide a **deep and narrow weld to the joint**.
3. For High Power Diode Lasers (HPDL), the combination of high power output and comfortable spot sizes allows for optimum gap bridgeability.
4. The **energetic homogeneity of the spot** and **the high absorption capacity of a typical wavelength mix** generate calm melt pools that leave almost no impurities on the areas adjoining the seams through spatters or wavelets.

Laser Beam Parameters

- Power Density: 5×10^4 to 10^7 W/cm² (CO₂ and Solid state lasers), 1×10^4 W/cm² and 2×10^5 W/cm² (High power diode laser)
- Wavelength: order of 10 μ m (CO₂ lasers), order of 1 μ m (solid state lasers) and 790-980 nm (HPDL)
- Intensity: 106 W/cm²
- Spectral line width (Diode laser): 450nm
- Power : 10W to 8 kW
- Efficiency: 5-20% (CO₂ lasers), 10-20% (solid state lasers) and 65% for HPDL

Laser Beam Parameters

- Beam size: $\sim 2.5\text{-}5\text{mm}$ (either circular or astigmatic/elliptical) for HPDL,
- Beam Divergence: $0.5\text{-}1\text{mrad}$ (either circular or astigmatic/elliptical) for HPDL,

References

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- Salminen, Antti, Anssi Jansson, and Veli Kujanpaa. "Effect of welding parameters on high-power diode laser welding of thin sheet." *High-Power Diode Laser Technology and Applications*. Vol. 4973. SPIE, 2003.