Laser Welding of Light Weight Materials

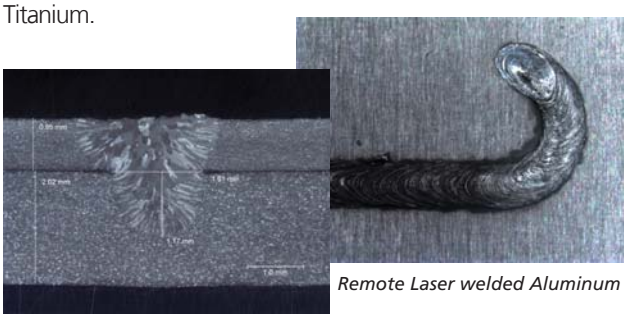
Fraunhofer USA

Center for Coatings and Laser Applications

Making innovation a reality

Light Weight Vehicle Technology

Interest in lightweight vehicle technology is increasing due to industry competition and federal regulations related to fuel efficiency. The federal fuel efficiency standards for cars and light trucks require that the average car shall achieve a fuel economy performance equivalent to 54.5 mpg by 2025, nearly double that of cars on the road today. Due to it's high energy density, low heat input and high automation, laser beam welding is one of the most productive methods for joining lightweight alloys such as Aluminum, Magnesium and Titanium.

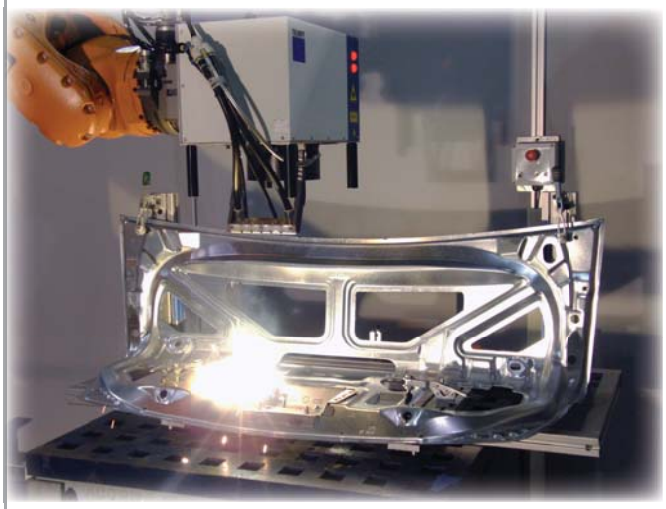


Remote Laser welded Aluminum

Cross Section (left) and Surface Profile (right)

Aluminum Properties

- Light – 2.7g/cm³ --> Approximately 34% mass of Steel
- High strength-to-weight ratio – depending on alloy and heat treatment, up to 300 MPa
- Corrosion resistant
- Difficult to resistance weld due to high electrical conductivity
- Readily laser weldable



High Speed Remote Laser Welding of Automotive Assembly

Remote Laser Welding of Aluminum

Lasers for Aluminum Welding

Fraunhofer has the following state of the art lasers at its Plymouth facility.

- Disk Laser
- Fiber Laser
- Diode Laser
- CO_2 Laser

Laser welded Aluminum Driveshaft

Applications of Aluminum in Cars

- Closures (Doors, Tailgate)
- Covers, Housings, Brackets
- Body Structure
- Engine Components
- Suspension Components
- Powertrain Components
- Batteries

Laser Welding Processes

- Autogenous Welding (without Filler Wire)
- Laser Welding with Filler Wire (Changing weld composition and geometry)
- Laser Hybrid Welding (MIG/TIG/Plasma)
- Remote Laser Welding (Fiber/Disk Laser)

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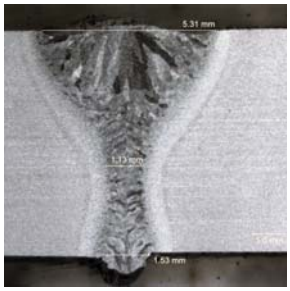
Titanium for Aerospace Applications

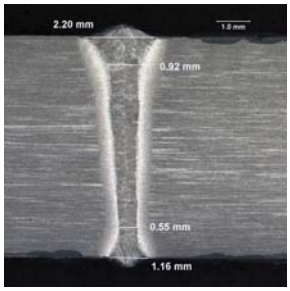
Lightweight structures for aerospace applications can be achieved by the use of materials with high strength to weight ratios such as Carbon fiber reinforced composites and Titanium alloys. Titanium alloys are good choices for applications in aircraft components when higher strength is required. Titanium alloys are also very compatible with Carbon fiber reinforced composites in terms of contact corrosion and low thermal coefficient.

Titanium Properties

- Light - Density of 4.5g/cm³ --> Approximately 57% mass of Steel
- High strength and fatigue properties, even at high temperatures
- Corrosion resistant, in particular in connection with carbon fiber
- Different machining and welding techniques required
- Readily laser weldable



Laser welded Titanium



Laser welded Titanium

Magnesium Properties

- Light - Density of 1.7g/cm³ --> Approximately 22% mass of Steel
- Readily laser weldable

Magnesium is one of the lightest structural metals available today, and Magnesium alloys offer great potential for mass reduction for transportation applications.

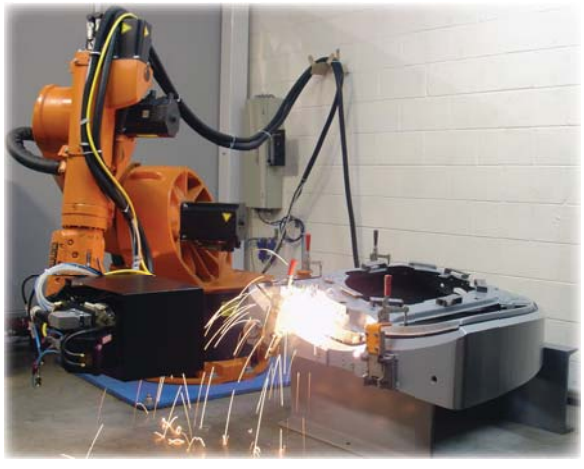
Fraunhofer CCL has considerable experience in developing laser welding processes for light weight metals such as Aluminum, Titanium and Magnesium using our state of the art fiber, disk, diode and CO_2 lasers.

Applications

- Fuselage frame components
- Turbine blades for high temperature applications
- Brackets, housings, wing structures, landing gear
- Tubes, exhaust pipes
- Fasteners

Laser Welding Processes

- Laser Welding with and without Filler Wire (Changing weld composition and geometry)
- Laser Hybrid Welding (Laser + MIG or Plasma Process)
- Remote Laser Welding
- Crack Repair (using wire or powder filler)



Remote Laser Welded of Magnesium Automotive Door Assembly

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