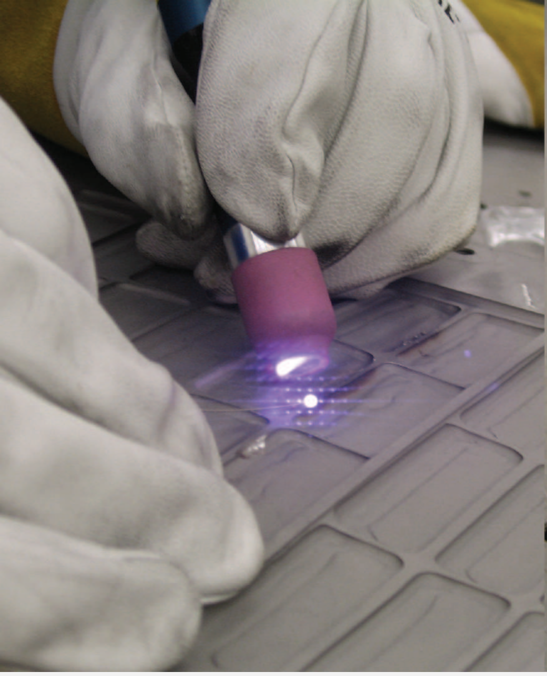
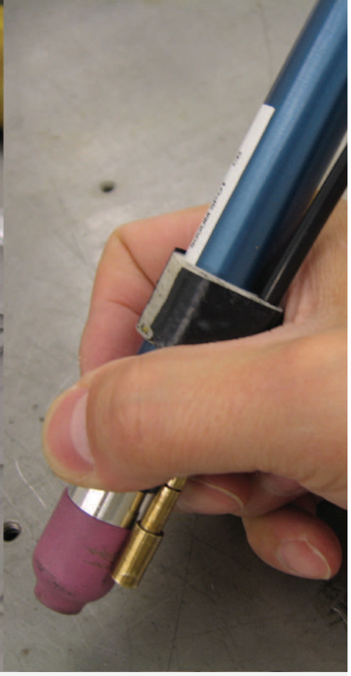

National Aeronautics and
Space Administration

Manufacturing

Variable-Power Handheld Laser Torch

for Joining Processes

NASA's Marshall Space Flight Center developed the handheld laser torch, designed for welding and brazing metals, to repair hard-to-reach Space Shuttle engine nozzles. It incorporates various manual controls and changing lenses to allow the operator to adjust the lasers power output in real time. The controls and lenses are designed to increase precision, portability, and maneuverability as compared to existing automated lasers and traditional welding techniques such as tungsten inert gas (TIG), metal inert gas (MIG). or gas-tungsten arc welding (GTAW) systems. Proximity sensors with automated shut-off switches also ensure a high level of safety for the user.

BENEFITS

- As compared to TIG or MIG welding, the NASA torch offers:
- Enhanced accuracy: Variable lenses allow the user to adjust power in real time, depending on circumstantial welding needs.
- Increased portability and maneuverability: Handheld form allows the user to braze in small or hard-to-reach places.
- Improved user safety: Added sensors and emergency switches boost user safety.
- Decreased heat affected zone: The laser applies heat to a very localized working area to prevent damage to the welding surface.

APPLICATIONS

- Opportunities include various welding applications where real-time laser variation may be needed due to the spatial/accuracy constraints of traditional welding methods:
- Aerospace engine repair
- Medical hardware manufacturing
- Plastic mold and die restoration
- Jewelry manufacturing and repair

technology solution

THE TECHNOLOGY

Features of the handheld torch's design include manual controls to modify the laser diameter and power output in real time. This ability allows the user to adjust the laser depending on circumstantial needs, resulting in a torch that is well suited for in-field repairs of metals where space and time are constrained. The primary applications are likely to be in-field welding and brazing of damaged specialized equipment.

The laser technology is a variable-power, continuous-wave, handheld fiber laser torch for brazing metals with an increased precision and maneuverability. The laser hardware and supply measures 24 inches in length, 15 inches in width, and 30 inches in height, with a torch diameter of about 0.8 inches. This size is nearly half that of traditional welding systems, which increases the portability of the machine as well as the welder's maneuverability.

The current handheld torch replaces earlier versions of handheld torches that cost over $700K to produce and had much larger footprints. After numerous design improvements and the inclusion of a commercial off-the-shelf fiber laser, the third-generation NASA torch is much smaller, with the handheld component being about 2.5 times larger than standard ink pens. The NASA handheld torch and system integration is estimated to cost between $60K and $70K.

NASA has used the handheld laser on Haynes 230 super alloy to improve localized repair procedures. Preliminary tests produced a consistent data set of yield strength (YS), ultimate tensile strength (UTS), and percent elongation (%EL) that are comparable to the results of current GTAW techniques.

Specimen		Temp °F	YS (ksi)	UTS (ksi)	%EL
Plate 01	1	70	68	112	27
	2	70	68	118	36
	3	1700	30	31	8
Plate 02	4	70	65	100	19
	5	70	64	103	24
	6	1700	32	33	3
*GTAW 230 W Weld Metal		70	75.7	112.6	27.3
		1800	21.2	22.7	24.6

Two sets of plates were welded, and six tensile specimens were evaluated and tested; comparable results to GTAW techniques are demonstrated. Weld specimen Plate 01 demonstrates full penetration of Haynes 230 super alloy using the handheld laser.

Haynes 230 Super Alloy weld specimens demonstrate the repair of thin- walled pockets. Top photo: Plate 01 Full Penetration. Bottom Photo: Plate 02 Partial Penetration

PUBLICATIONS

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More Information

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