

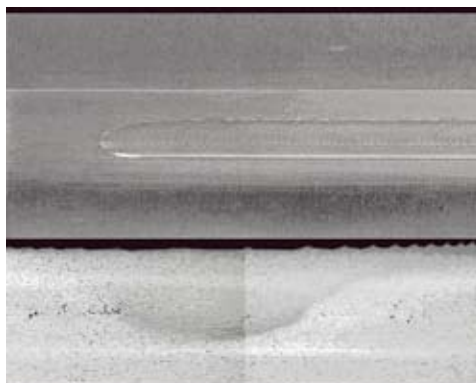
AEROSPACE MANUFACTURING TECHNOLOGY

Solid-State Joining

The NRC Institute for Aerospace Research (NRC Aerospace) has the expertise and facilities to investigate solid-state joining for the manufacture of aerospace components. The focus of current investigations is on friction stir and linear friction welding technologies.

Friction stir welding

Expertise in friction stir welding is being developed using an MTS ISITIR system capable of solid-state (no melting) processing of aerospace materials. The technology uses frictional heat generated by a rotating spindle travelling along a joint to weld two components. Friction stir welded joints are characterized by low distortion, low porosity, no shrinkage, and superior mechanical properties due to their refined microstructure. It can be used to join dissimilar and traditionally non-weldable materials and has shown promise as an alternative to the use of rivets to join aircraft structures. Currently, studies are underway on process development and optimization of the technology for use in manufacturing airframe and engine components from various aerospace materials.



Friction stir welded aluminium sample showing a lap weld configuration (top) and weld microstructure (bottom)



Friction stir welding system

Equipment specifications:

Axis	Stroke	Speed	Force
X	41"	0-60 ipm	200 to 15,000 lbf
Y	24"	0-60 ipm	200,800 lbf
Z	12.5"	0.1-55 ipm	30,000 lbf torsion; 5,000 lbf compression
Tool Rotation	Infinite	200-2000 RPM or 50-800 rpm	1,600 lbf-in; 5,000 lbf-in with a gear reducer (4:1)
Pitch adjustment	±15°	0.1-300 min-1	200-20,000 lbf
Adjustable pin	1.25"	0.1-50 ipm	20,000 lbf

Linear friction welding

NRC Aerospace is using a pilot-scale linear friction welder for process development studies aimed at helping Canadian companies evaluate the technology for use in manufacturing

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near net shape components. Linear friction welding relies on pressure and linear reciprocating movement to generate sufficient heat to soften and join two components. It creates reproducible, high-quality welds having small heat-affected zones and excellent mechanical properties. Dissimilar materials can be joined, as well as components with irregular cross-sections or complex shapes, with minimal material loss. Projects are currently underway to investigate the applicability of this technology for welding nickel-based superalloys, ultra high strength steels and titanium alloys.

Equipment specifications:

- Forge actuator:
 - Forge load: 60 kN to 90 kN (13,500 to 20,250 lbs)
 - Displacement: ± 6 mm (1/4")
- In-plane actuator:
 - Friction force: 50 kN (11,250 lbs)
 - Displacement: ± 10 mm (3/8")
 - Amplitude range: ± 0.2 mm to ± 5 mm (3/16")
 - Frequency range: 15 Hz up to 125 Hz
- Hade axis:
 - Side force: up to 10 sec.



Linear friction welded titanium sample



Linear friction welding equipment

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