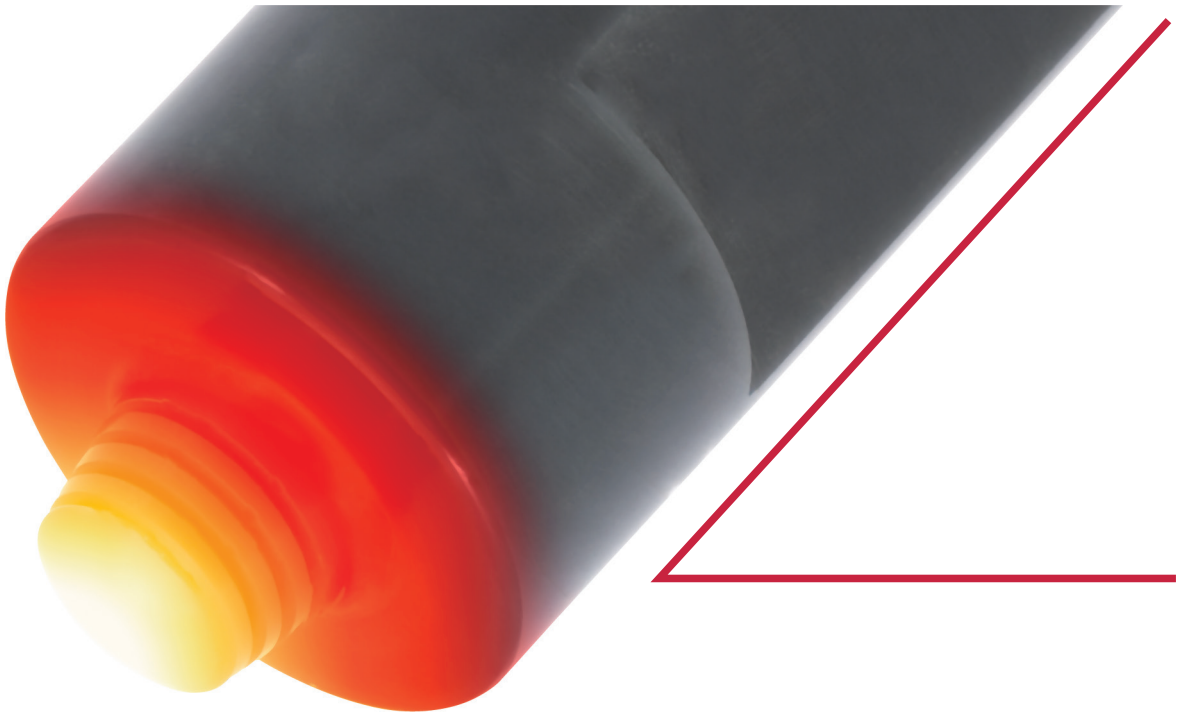


FSW TOOL

Friction stir welding Ceramic tool | Carbide tool



*FSW Evolution for Ferrous Metals
Driven by Ceramic Materials and Advanced Engineering*



CERtainly (but not only) ***CERamics***
Outstanding solutions for demanding applications



I Advantages of FSW

- Solid state joining without melting
- High-strength, high-quality welds
- No spatter, fumes, or harmful emissions
- Enables dissimilar material joining
- Suitable for automation and mass production



For more information

I Ceramic & Carbide grade information

Image	Grade	Features
For Ferrous metals 	SiAlON Ceramics	High-performance SiAlON ceramic material with reinforced toughness, excellent thermal shock resistance, and outstanding wear durability
For Non-ferrous metals 	Fine particle cemented carbide	Enhanced toughness and superior resistance to chipping

I Welding conditions guideline

	Rotation speed (min ⁻¹)	Table feed (mm/min)
Ceramic	1,000 - 2,000	200 - 1,000
Carbide	1,000 - 4,000	1,000 - 2,000

Ceramic Solution

For welding temperature 1,000°C level



SiAlON Ceramics

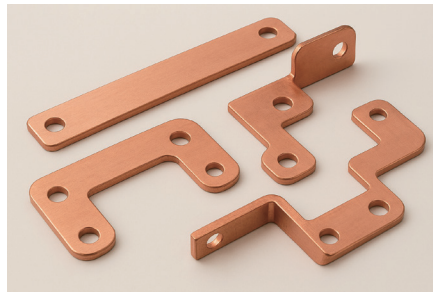
For **high** melting point metals

Ferrous metals / Stainless steel, Carbon steel

Non-ferrous metals / Copper



Stainless steel



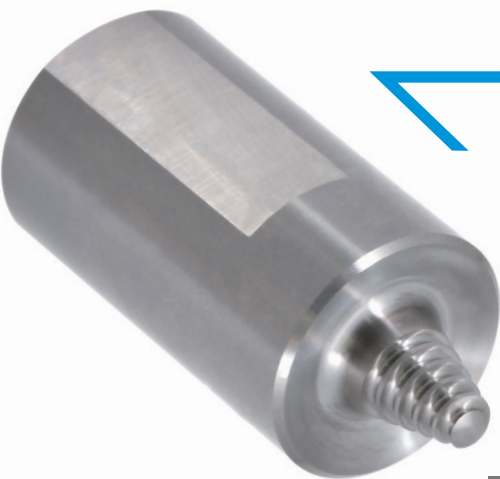
Copper



Carbon steel

Carbide Solution

For welding temperature 500°C level



Fine particle cemented carbide

For **low** melting point metals

Non-ferrous metals / Aluminum alloy, Die-cast



Aluminum



I Dimensional ref. for custom made product

All FSW tools are custom-made. Please ensure that the tool design falls within the dimensional limits (diameter and length) specified below, as there are manufacturing constraints.

Tool

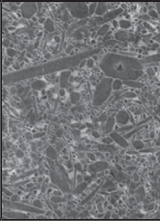


For ferrous metals

CERAMIC

I High Strength SiAlON Ceramics

Material



Physical properties[※]

Density g/cm ³	Hardness HRA	Transverse intensity MPa	Young's modulus GPa	Thermal expansion coefficient X10 ⁻⁶ /K	Thermal conductivity W/m·K
3.3	93.5	1,200	330	3.0	15

Tool

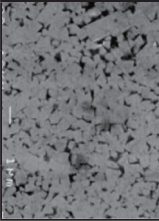


For Non-ferrous metals

CARBIDE

I Fine Particle Cemented Carbide

Material



Physical properties[※]

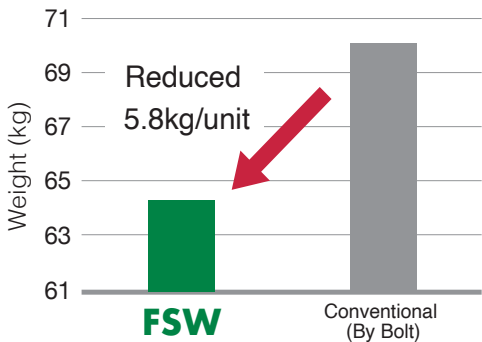
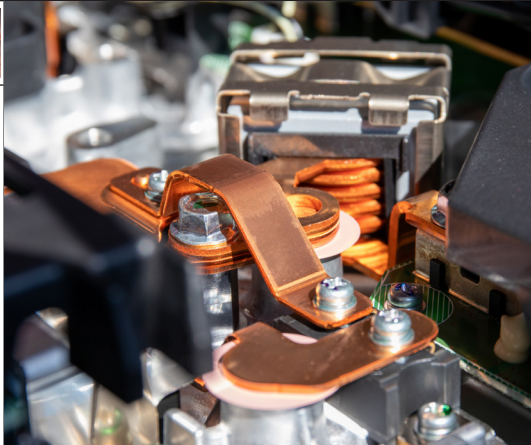
Density g/cm ³	Hardness HRA	Transverse intensity MPa	Young's modulus GPa	Thermal expansion coefficient X10 ⁻⁶ /K	Thermal conductivity W/m·K
14.4	91.0	3,000	580	5.8	63

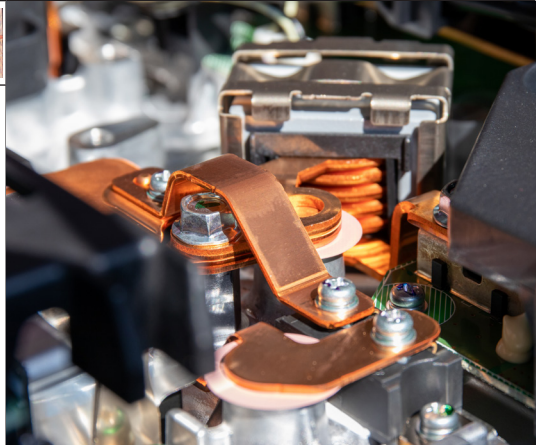
Blank dimensions	Metric		Inch	
	Diameter	Length	Diameter	Length
	φ6mm	28mm	.236"	1.102"
		60mm		2.362"
	φ8mm	28mm	.315"	1.102"
		60mm		2.362"
	φ10mm	31mm	.393"	1.220"
		65mm		2.559"
	φ12mm	32mm	.472"	1.260"
		70mm		2.756"
	φ16mm	35mm	.630"	1.378"
		41mm		1.614"
		75mm		2.953"
	φ20mm	43mm	.787"	1.693"

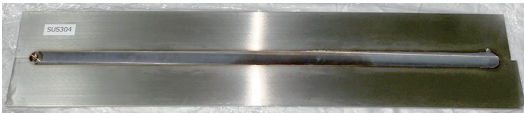
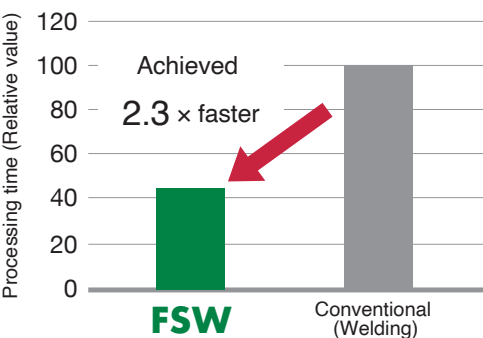
Metric		Inch	
Diameter	Length	Diameter	Length
φ6mm	38mm	.236"	1.496"
	80mm		3.150"
φ8mm	38mm	.315"	1.496"
	80mm		3.150"
φ10mm	28mm	.393"	1.102"
	60mm		2.362"
φ12mm	32mm	.472"	1.260"
	70mm		2.756"
φ16mm	38mm	.630"	1.496"
	80mm		3.150"
φ20mm	48mm	.787"	1.890"
	100mm		3.937"

The tool shape shown in the photo is for illustrative purposes only; actual shapes may vary.
Custom made products are manufactured by precision grinding from the blanks shown above.

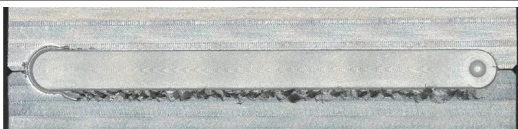
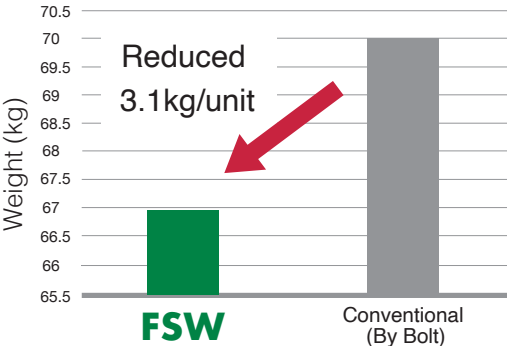
I Practical examples

	NTK FSW		Competitor						
Industry	Automotive								
Component	Busbar								
Material ISO code	N N - Non-ferrous metal C1020								
Machine (spindle type)	FSW Machine	None							
Grade	Ceramic	Bolt fastening							
Tool shoulder diameter	ϕ 10								
Rotation speed (min ⁻¹)	1,910								
Welding speed (m/min)	60								
Table feed (mm/min)	573								
Feed rate (mm/rev)	0.3								
Joint image									
Results	 <table border="1"><thead><tr><th>Method</th><th>Weight (kg)</th></tr></thead><tbody><tr><td>FSW</td><td>64.2</td></tr><tr><td>Conventional (By Bolt)</td><td>70.0</td></tr></tbody></table>		Method	Weight (kg)	FSW	64.2	Conventional (By Bolt)	70.0	
Method	Weight (kg)								
FSW	64.2								
Conventional (By Bolt)	70.0								
Benefits	• Eliminating bolts, contributes to weight reduction • Save cost for bolts								

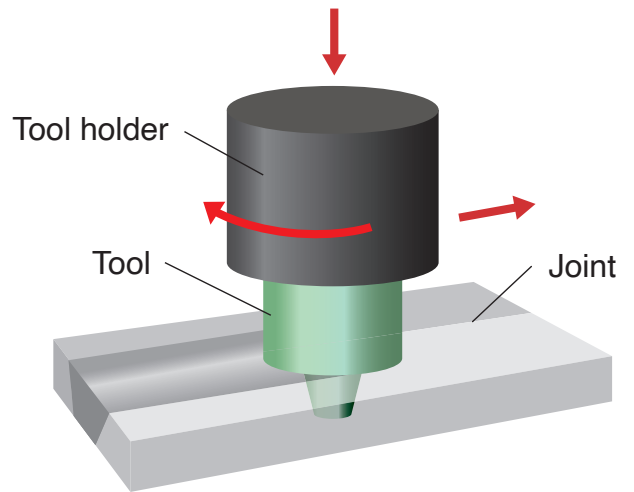


	NTK FSW	Competitor
Industry	Heavy	
Component	Hull parts	
Material ISO code	M M - Stainless steel SUS304	
Machine (spindle type)	FSW Machine	Welding machine
Grade	Ceramics	-
Tool shoulder diameter	$\phi 16$	-
Rotation speed (min^{-1})	1,375	-
Welding speed (m/min)	69	-
Table feed (mm/min)	275	120
Feed rate (mm/rev)	0.2	-
Joint image		
Results		
Benefits	• Achieved 2.3x reduction in processing time compared to conventional welding.	



	NTK FSW	Competitor
Industry	Automotive	
Component	Battery case	
Material ISO code	N N - Non-ferrous metal ADC12 & A6061	
Machine (spindle type)	Vertical Machining Center	None
Grade	Carbide	Bolt fastening
Tool shoulder diameter	ϕ8	
Rotation speed (min ⁻¹)	4,000	
Welding speed (m/min)	100	
Table feed (mm/min)	1,000	
Feed rate (mm/rev)	0.25	
Joint image		
Results		
Benefits	• Eliminating bolts, contributes to weight reduction. • Significant weight reduction can be expected by replacing conventional bolt fastening with FSW for busbar component joining.	

I Description of FSW tool



Manufacturable tool diameter

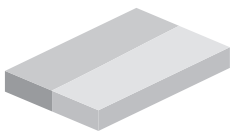
(Metric) : $\phi 6$, $\phi 8$, $\phi 10$, $\phi 12$, $\phi 16$, $\phi 20$ mm

(Inch) : .236" / .315" / .393" / .472" / .630" / .787"

I Key points to make FSW tools

 Essential for creating optimal tools—please collect with care.

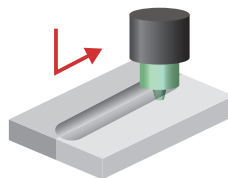
Workpiece Information



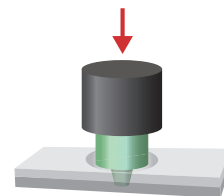
☐ Workpiece material : _____ & _____

☐ Workpiece thickness : _____ mm

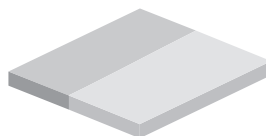
Welding method



☐ Line welding or



☐ Spot welding



☐ Butt joint or



☐ Lap joint

Machine power & Spindle interface

☐ Thrust force resistance : _____ N
ex. 5,000 N

&

☐ Spindle interface : _____
ex. BT50 / HSK100



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