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—搅拌摩擦焊专家—



# 搅拌摩擦焊耗材—搅拌头

## Friction Stir Welding Supplies—FSW Tools



### 北京世佳博科技集团有限公司

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2024版



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用心焊好每条缝，这是世佳博对您的庄严承诺

Sooncable cherish every FSW chance — our solemn promise to you



搅拌摩擦焊技术广泛应用于航空、航天、船舶、轨道交通、汽车、兵器、电力电子、冶炼、民用建筑等领域。  
Widely used in aviation, aerospace, ships, rail transport, automobiles, weapons, power electronics, smelting, civil construction and other fields.

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## 关于我们

About Us

北京世佳博科技集团有限公司（以下简称世佳博）2014年成立于北京，立足中国，服务全球市场。在河北固安、江苏昆山、重庆渝北、广东东莞设有分公司，拥有经验丰富的搅拌摩擦焊接专家团队、工业企业技术研发中心，是搅拌摩擦焊细分领域全球知名的“整体解决方案”提供商，是“国家高新技术”企业、“中关村高新技术”企业、“北京市专精特新”认定企业、“先进工业母机”制造企业、“知识产权管理体系”贯标企业。



Beijing Sooncable Technology Group Co., Ltd (Sooncable), was established in Beijing in 2014, based in China and serving the global FSW market. We have branches in Hebei, Jiangsu, Chongqing and Guangdong. The company has an experienced team of friction stir welding experts, “Provincial industrial enterprise accreditation” technology research and Development Center.

## 业务范围

公司在搅拌摩擦焊接领域、散热技术领域、大型机械装备制造领域、金属材料加工、有色金属材料成型等领域拥有丰富经验，可为来自航空、航天、船舶、轨道交通、汽车、兵器、电力电子、冶炼、民用建筑等领域客户提供快捷高效的搅拌摩擦焊接服务。

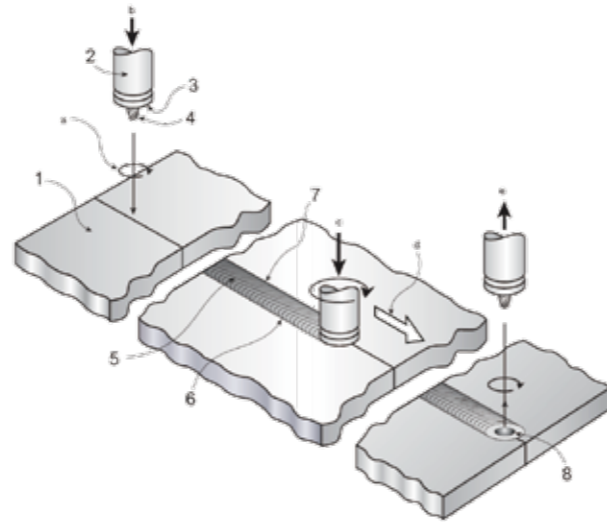


Sooncable has rich experience in the field of Friction Stir Welding, heat dissipation technology, large-scale mechanical equipment manufacturing, metal material processing, Al-alloy decasting and molding, and can provide fast and efficient FSW services for customers from Aviation, Aerospace, Ship-building, rail transit, Automobile, Weapon, Power- electronics, Smelting, Civil Construction and other fields.

## 搅拌摩擦焊接原理

### Principle Of FSW

- ▶ 搅拌摩擦焊是一种纯机械化连续的固相连接方法。搅拌摩擦焊过程中，一个柱形带特殊轴肩和针凸的搅拌摩擦焊接工具（搅拌头）旋转着缓慢插入被焊工件的待焊接处，搅拌头和被焊材料之间的摩擦剪切阻力产生了摩擦热，使材料软化发生塑性变形，并释放出塑性变形能，当搅拌头受到驱动沿着待焊界面向前移动时，热塑化的材料由搅拌头的前部向后部转移，并且在搅拌头轴肩的锻造作用下，实现工件之间的固相连接。



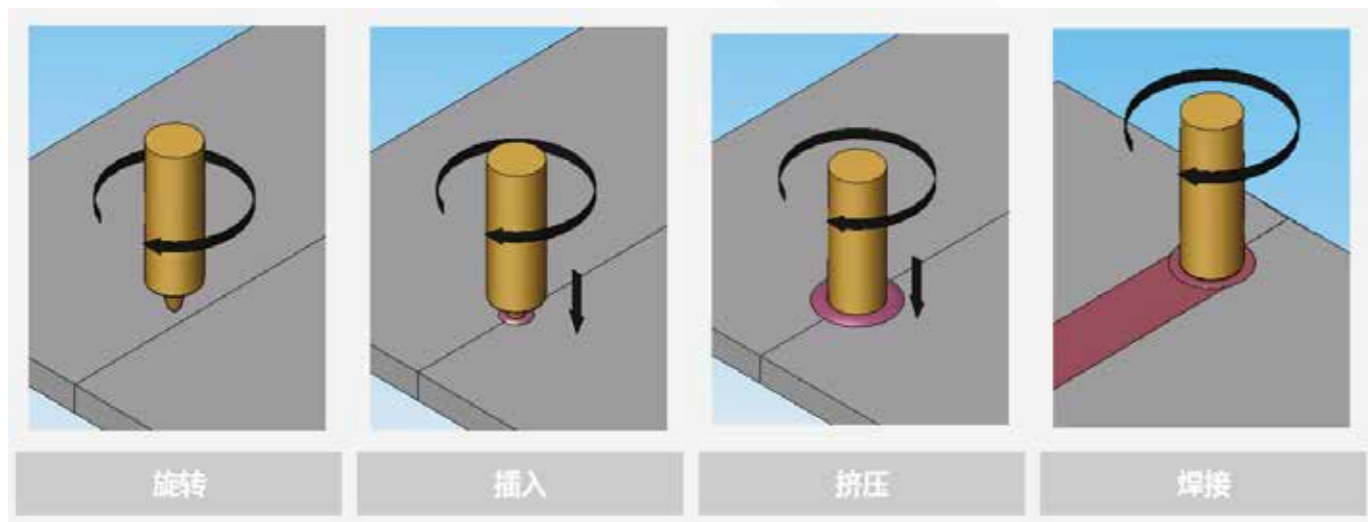
Friction stir welding (FSW) is a pure mechanical continuous solid phase bonding method. In the process of FSW, a cylindrical FSW tool with special shoulder and pin convex rotates and slowly inserts into the welding position of the workpieces.

## 搅拌摩擦焊接过程

### Process Of FSW

- ▶ 搅拌摩擦焊接过程依次需要历经四大过程，分别是搅拌头旋转、缓慢插入、挤压生热、施加顶锻压力，实施焊接。有别于传统的焊接方法，搅拌摩擦焊接过程是一个冷加工过程，焊接后获得的是锻造组织结构的接头。因此，搅拌摩擦焊被认为是焊接史上的重大突破，将为有色金属的连接工艺起到积极的推动作用。

The process of friction stir welding needs to go through four major processes in turn, which are rotation of the stirring head, slow insertion, extrusion heat generation, world top forging pressure, and implementation of welding.



## 搅拌摩擦焊工具

### Friction Stir Welding

- ▶ 搅拌摩擦焊过程中，一个具备特有的搅拌摩擦焊接工具（搅拌头）在待焊工件之间进行挤压、摩擦、混合、扩散。搅拌头是搅拌摩擦焊接过程中的主要消耗品，是实现搅拌摩擦焊的重要环节之一，被誉为搅拌摩擦焊的“心脏”。

世佳博组建了以搅拌摩擦焊接专家、博士为核心的搅拌头设计团队、精选国外纯进口搅拌头原材料、采用高精度生产加工设备、严格管控热处理流程、搅拌头表面涂层、产品包装及产品出厂检验等流程，确保搅拌头产品性能优异。



As the main consumable in the process of friction stir welding (FSW), FSW tool is one of the important links to realize friction stir welding, which is known as the "core" of FSW.

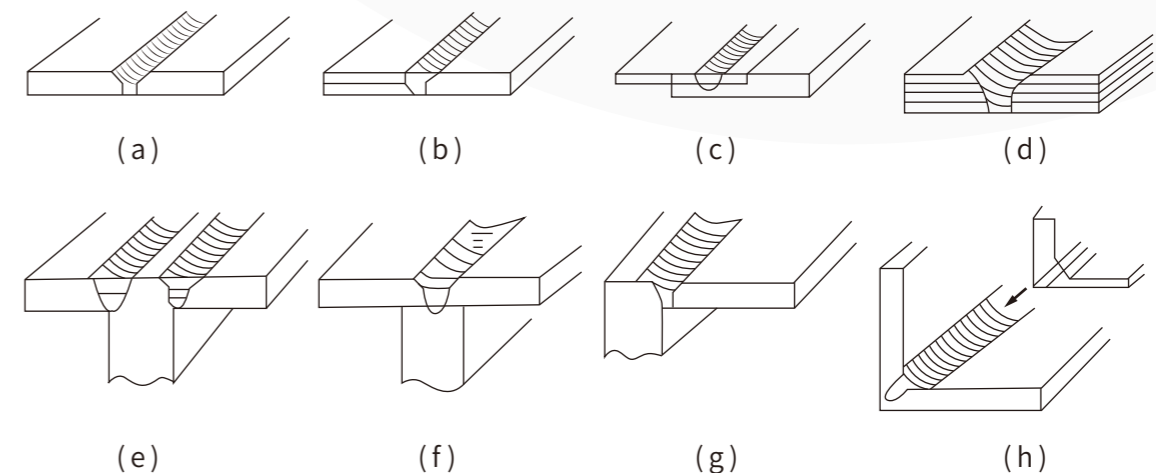
We company has set up a FSW tool design team with FSW experts and doctors as the core, select foreign pure imported raw materials, adopt high-precision production and processing equipment, strictly control the heat treatment process, surface coating, product packaging and product delivery inspection, so as to ensure the excellent performance of FSW tool products.

## 焊缝形式

### Weld form

- ▶ 可满足的接头形式：单层对接接头 [图(a)]、双层对接接头[图(b)]、单层搭接接头 [图(c)]、多层搭接或对接接头 [图(d)]及T型接头[图 (e)~ (h)]。

The types of joints that can be satisfied are: single-layer butt joint [ figure (a) ], double-layer butt joint [ figure (b) ], single-layer lap joint [ figure (c) ], multi-layer lap or butt joint [ figure (D) ] and T-type joint [ figure (E) ~ (h) ].



## 标准化搅拌头

Standard Tools

### ▶ 铝合金搅拌头

铝合金具有较高的比强度、比模量、断裂韧性、疲劳强度以及耐腐蚀稳定性等优点，是轻量化过程中应用最广泛的一种合金材料。搅拌摩擦焊为铝合金的焊接质量带来了根本性的提高，是迄今为止最适合铝合金焊接的完美成型工艺，可实现铸铝+板材、铸铝+型材、铸铝+铸铝的焊接，以及特殊结构(深腔体结构)的焊接。

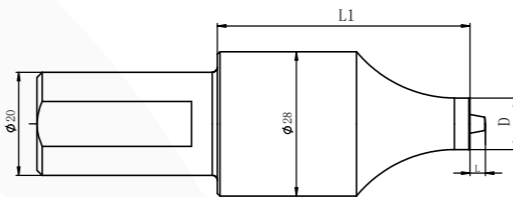
搅拌头特征：压铸材质焊速 > 300mm/min，单只搅拌头寿命 > 800m，焊接成本 < 0.7 元 /m；挤压型材焊速 > 1500mm/min，单只搅拌头寿命 > 1200m，焊接成本 < 0.5 元 /m。

Aluminum alloy is one of the most widely used alloy materials in lightweight process because of its high specific strength, specific modulus, fracture toughness, fatigue strength and corrosion resistance.



### Sooncable FSW Tools for Al-alloy

可焊材料	L1	L	D
铸造铝合金 1XXX-7XXX	标准49mm 可定制	0.5mm	3.4-4mm
		0.5-3mm	5-12mm
		3-5mm	8-15mm
		5-8mm	12-20mm
		8-12mm	18-24mm
		12-16mm	24-32mm
		17-45mm	29-55mm



### ▶ 铜合金搅拌头

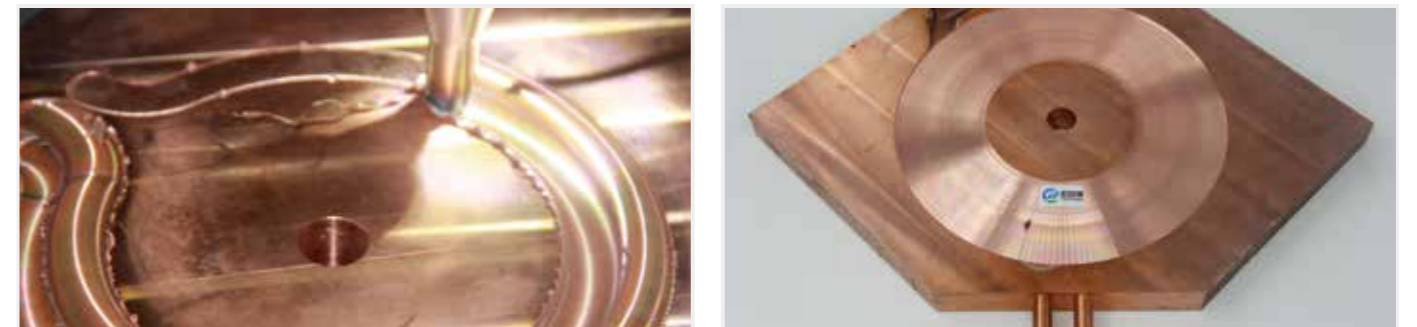
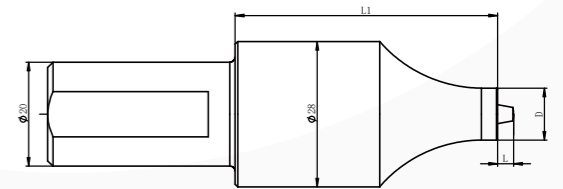
铜合金是现代工业常用材料之一，具有优良的导电性、导热性、延展性和耐腐蚀性等特性，已广泛应用于轨道交通、电气控制、电力电子及食品医疗等行业可实现紫铜、黄铜、青铜等铜合金的搅拌摩擦焊接，针对此领域，目前我司在大力研发 15mm 以上铜合金的焊接。

Copper alloy is one of the common materials in modern industry, which has excellent electrical conductivity, thermal conductivity, ductility and corrosion resistance, has been widely used in rail transit, electrical control, power electronics and food and medical industries.



### Sooncable FSW Tools for Al-alloy

可焊材料	L1	L	D
紫铜、黄铜 青铜	标准49mm 可定制	1-2mm	8-12mm
		2-4mm	12-15mm
		4-6mm	15-18mm
		5-8mm	15-28mm
		8-15mm	18-37mm



► 高温合金搅拌头

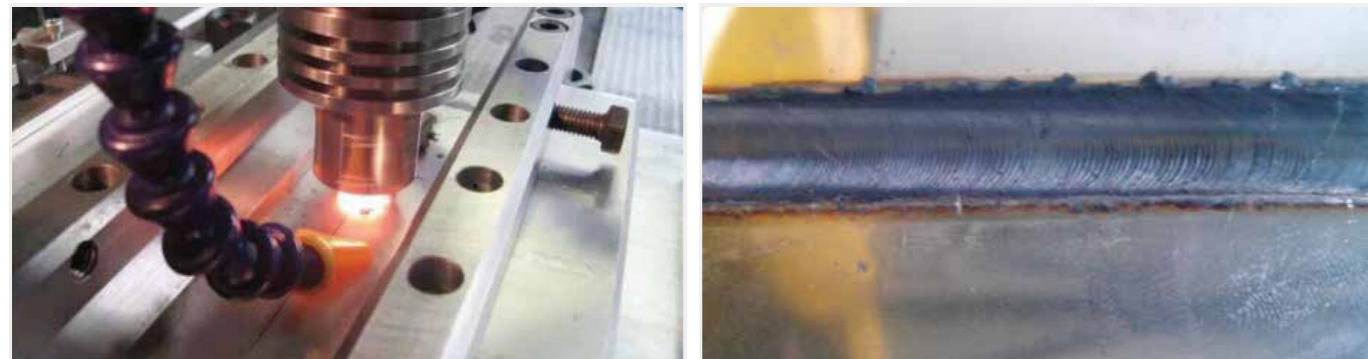
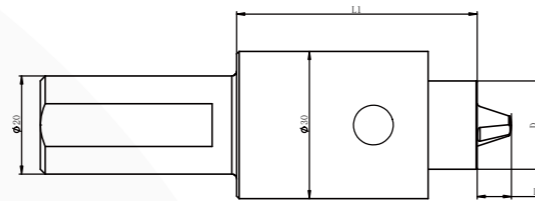
高温合金搅拌头可用于熔点 600°C 以上材料如：钢合金、钛合金、镍基合金等，可以实现 1-6mm 钛合金与镍基合金及 1-12mm 钢合金的完美焊接成型，焊接强度达到母材强度的 92% 以上。

High temperature alloy stirring head can be used for materials with melting point above 600 ° C, such as steel alloy, titanium alloy, nickel-base alloy, etc. , the welding strength is over 92% of the base metal strength.



Sooncable FSW Tools for Al-alloy

可焊材料	L1	L	D
钢合金、钛合金	标准49mm 可定制	2-3mm	12-15mm
		3-7mm	15-18mm
		7-12mm	18-25mm



► 镁合金搅拌头

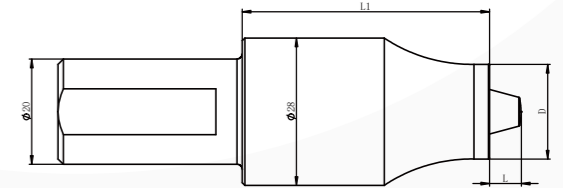
镁合金具有密度低、比强度高、比弹性模量大、散热性与消震性好、承受冲击载荷能力强以及耐腐蚀性强等诸多优点，是轻量化领域的重要原材料。世佳博在镁合金的搅拌摩擦焊接领域，已取得了丰富的经验并成功实现多种类型搅拌头的工业化应用，可以实现 20mm 以下镁合金的完美焊接成型，焊接形式包括对接、搭接、对搭接。产品结构包括直缝、平面二维、筒体纵缝、筒体环缝、空间曲面焊接以及箱体结构。

Magnesium alloy has many advantages, such as low density, high specific strength, large specific elastic modulus, good heat dissipation and shock absorption, strong resistance to impact load and corrosion resistance.



Sooncable FSW Tools for Al-alloy

可焊材料	L1	L	D
镁合金	标准49mm 可定制	2-3mm	10-15mm
		3-7mm	12-18mm
		7-12mm	18-25mm
		12-20mm	24-35mm



## 定制式搅拌头

Customed Tools

### ▶ 静轴肩搅拌头装置

静轴肩搅拌头焊接过程中通过静轴肩装置,使轴肩在静止状态下从工件表面滑动,从而可对焊缝提供更大的锻压力,实现比动轴肩焊缝强度增加的效果,同时由于塑性金属受到静止轴肩、搅拌针两侧冷态金属以及垫板的刚性约束,有效地阻止了材料外溢和流失,而形成无减薄焊缝。目前,主要应用于电池托盘和宽幅型材的焊接。焊接速度可达 800-2000mm/min,成本最低至 0.8 元 /m,可根据产品结构特殊性,定制专用的搅拌头与轴套相匹配。

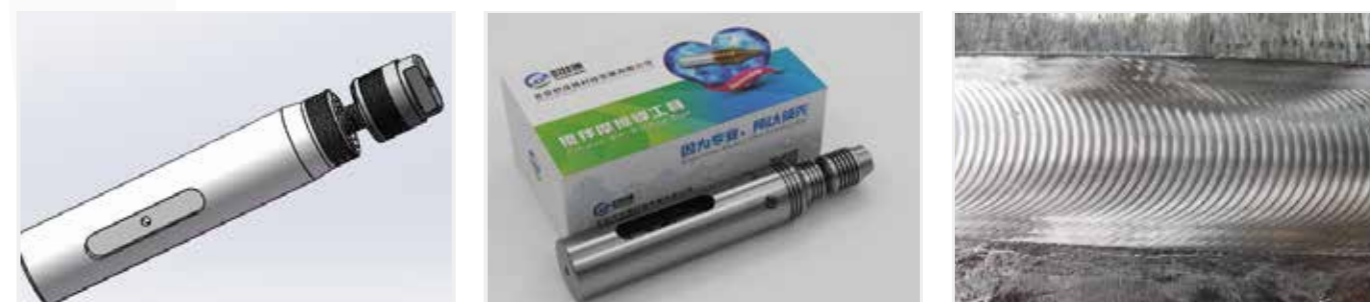
In the welding process of the static shoulder stirring head, the static shoulder device makes the shoulder slide from the surface of the workpiece in the static state, thus providing greater forging pressure to the weld seam, and realizing the effect of increasing the strength of the weld seam compared with the dynamic shoulder.



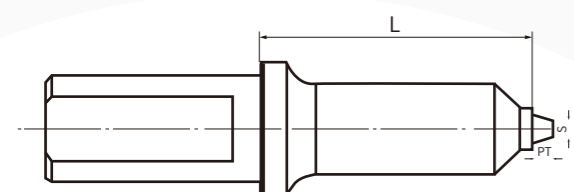
### ▶ 双轴肩搅拌头

双轴肩搅拌摩擦焊是常规 FSW 的衍生技术。双轴肩搅拌头以一定的速度旋转进入被焊工件对接面,使上、下轴肩分别与被焊工件上、下表面紧密接触,利用轴肩和搅拌针与被焊工件之间的摩擦与材料形变,产生摩擦热和塑性流动。当焊具沿焊接方向移动时,塑性金属在搅拌针和轴肩的摩擦挤压作用下发生流动实现无支撑条件下被焊工件的冶金连接,世佳博可实现这种形式的 3-16mm 厚度焊接。

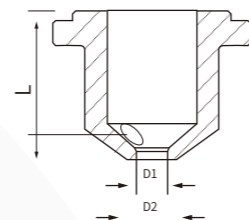
Dual shoulder friction stir welding is a derivative of conventional FSW. The double shaft shoulder stirring head rotates into the butt surface of the welded workpiece at a certain speed, so that the upper and lower shaft shoulders are in close contact with the upper and lower surfaces of the welded workpiece respectively, friction heat and plastic flow are produced by friction and material deformation between shaft shoulder and stir pin and welded workpiece.



## Sooncable FSW Tools for Al-alloy



系列	L	PT	S
SCB-CI-dz-jz	标准51mm 可定制	1-2mm	6mm
		2-3mm	6.5mm
		3-4mm	8mm
		4-5mm	8.5mm



系列	L	D1	D2
SCB-CI-jz-T	标准28mm 可定制	5.5mm	6mm
		6.5mm	10mm
		8mm	10mm
		8.5mm	12mm



### ▶ 可回抽搅拌头

可回抽搅拌摩擦焊技术是传统搅拌摩擦焊接方式一种有益补充,通过对焊机头的针对性改造,使搅拌针焊缝末尾一定区域内逐渐回抽,实现搅拌摩擦焊接焊缝“无匙孔”。采用该方法焊接的焊缝平整,中心没有凹陷,世佳博设计研发的回抽式搅拌头,可满足 12mm 以内板厚焊接,其中 3mm、5mm 为成熟结构,已有量产项目,并得到一致好评。

Recoverable friction stir welding technology is a useful supplement to the traditional friction stir welding method. Through the targeted modification of the welding head, the recoverable pin can be gradually withdrawn in a certain area at the end of the weld seam, weld "Key-hole-free" friction stir welding.



### ► 异种材料搅拌头

铜铝焊接在 SFW 上属于行业难点，铝合金和铜合金之间存在很大的化学、物理及力学性能差异，传统熔焊很难实现无缺陷连接。搅拌摩擦焊是一种依靠机械力和摩擦热作用实现的新型固相连接技术，可较好的实现热物理性能差异较大的金属连接，世佳博设计研发的铜铝搅拌头，经过大量的验证数据，迭代升级，现可满足 1-6mm 以内的铜铝对接，焊缝质量优异。

Copper-aluminum welding is a difficult point in SFW industry. There are great differences in chemical, physical and mechanical properties between aluminum alloy and copper alloy.



### ► 大厚度焊接搅拌头

大厚度搅拌头具有搅拌强度高，耐高温、焊接厚度大、使用寿命长、能有效抑制飞边空洞等优点，世佳博研发的大厚度搅拌头可实现 12-30mm 厚度及超大厚度 30-56mm 焊接。

The large thickness head has the advantages of high stirring strength, high temperature resistance, large welding thickness, long service life, and can effectively restrain flash hole, large thickness 30-56mm welding.



### 搅拌头配套产品

Supporting products

#### ► 搅拌头保养液

搅拌头使用一段时间后，轴肩部分会粘附一定厚度铝屑，可能造成焊接过程母材混合不均匀，焊缝性能下降等现象。为改善以上情况，世佳博独立开发搅拌头保养液，可有效清除表面附着，恢复外观光洁度，从而提高搅拌头寿命及焊接稳定性。

Independent development of head maintenance fluid, can effectively remove the surface adhesion, restore the appearance of cleanliness, thus improving the head life and welding stability.

#### ► 使用步骤

1. 使用前请充分摇匀保养液；
2. 擦除搅拌头表面油污；
3. 将搅拌头保养液倒入小容器中，使搅拌头轴肩部分完全浸入其内 0.5-3 小时；
4. 将浸泡好的搅拌头取出擦拭，需先在试板上焊接，再应用于产品焊接（长期不用时，表面需涂抹防锈油）。

- 1.Shake the FSF Tool Repairing Liquid well before using;
- 2.Remove oil stains from the surface of the FSF tools;
- 3.Pour the FSF Tool Repairing Liquid into a small container, and immerse the shoulder part of FSF tools for 0.5-3 hours;
- 4.Take out the soaked FSF tools and wipe them. Applying anti-rust oil on the surface of FSF tools when they are not used for such a long time.



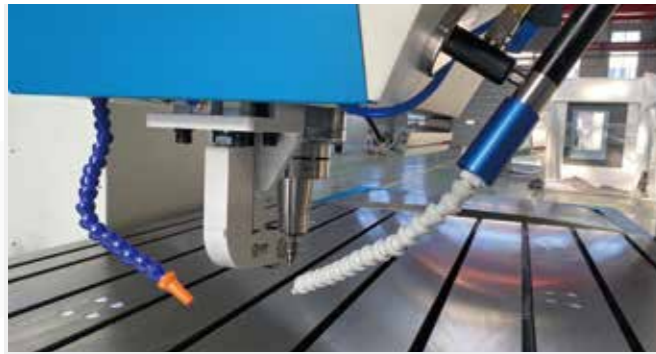
温馨提示	保养液倒出到容器中浸泡搅拌头以没过轴肩部分为佳	
浸泡时间	日常养护	10min
	轻度粘铝	20-30min
	重度粘铝	30min-1h
注意事项	液体不可直接接触皮肤，使用后不可倒回原液，密封储存	

## ▶ 急速气冷系统

世佳博本着在 SFW 领域解决焊接过程中的痛点、难点问题, 针对于提高搅拌头寿命、提高焊缝质量, 而研制开发了用于焊接过程中对工件及搅拌头急速冷却的装置 - 世佳博急速气冷系统。

急速气冷系统是根据搅拌摩擦焊技术特点研制开发, 用于焊接过程中对工件及搅拌头急速冷却的装置。可产生比压缩空气低 40°C 的洁净低温气流, 集冷却、吹屑、清洁于一身, 可在一定程度上延长刀具使用寿命, 减少工件热变形。

Based on solving the problems of pain and difficulty in the welding process in the field of SFW, we aim at improving the service life of stirring head and the quality of welding seam, the rapid air-cooling system of Shijiabo is developed for rapid cooling of work-piece and head in welding process. Rapid air cooling system is developed by sooncable according to the characteristics of FSW technology, which is used for rapid cooling of workpiece and FSW tool during welding.



急速气冷系统应用于龙门式搅拌摩擦焊接设备



急速气冷系统应用于台式搅拌摩擦焊接设备

### 【产品特点】

1. 使用工业标准压缩空气作为唯一动力来源, 免维护, 无活动部件;
2. 目前该产品已成功应用于托盘、壳体类产品的搅拌摩擦焊加工中, 冷却效果得到客户的一致好评;
3. 可产生比压缩空气低 40°C 的洁净低温气流, 集冷却、吹屑、清洁于一身, 可在一定程度上延长刀具使用寿命, 减少工件热变形。

### 【Product Features】

1. Use industry standard compressed air as the only power source, maintenance free, no moving parts.
2. At present, the product has been successfully applied to FSW of tray and housing, and its cooling effect has been well received by customers.
3. Produce clean low-temperature airflow 40°C lower than Compressed air, set cooling, dust blowing, cleaning in one, can extend the service life of the tool to a certain extent, reduce the thermal deformation of the workpiece;

## 增值服务

Value-added service

### ▶ 搅拌头工艺配套服务

为实现高效、稳定及低成本的搅拌摩擦焊工程领域的广泛应用, 除需要专用的搅拌头与搅拌摩擦焊装备外, 需要与之匹配的搅拌摩擦焊工装夹具及搅拌摩擦焊工艺规程。公司提供“专用搅拌头 + 匹配工艺参数”的定制式服务。该服务体系将包括: 专门开发的高性能搅拌头、高效率的搅拌摩擦焊工装夹具、科学的搅拌摩擦焊工艺规程, 可为您节省开发成本并缩短产品开发过程。

Provide customized service of "special mixing head matching process parameters". The service system will include: specially developed high-performance mixing head, high-efficiency friction stir welding fixture, scientific friction stir welding process procedures, which can save you development costs and shorten the product development process.



### ▶ 世佳博优势

1. 精密加工: 成熟的设计经验与加工工艺, 高精度的进口设备, 有庞大的参数验证数据, 保证焊缝质量;
2. 严选原料: 选用高端原料, 先进热处理工艺, (达到合适的硬度及韧性)、涂层工艺, 过程控制严格, 可达到焊接稳定持久 6 系铝合金标准搅拌头寿命可达 1500 米以上;
3. 有效追溯: 百万级检测设备保证产品精度, 编码追溯至原料进厂;
4. 快速响应: 标准搅拌头 3 个工作日内发货, 定制类给予专业建议, 配合定型;
5. 可实现 1-2 次的返修, 节省成本至少 50%。

Select high-end raw materials, mature design experience and processing technology, high-precision imported equipment, a large number of parameter verification data to ensure weld quality, million level testing equipment to ensure product accuracy, the code traces back to the raw material entering the factory.



丰富的产品与解决方案



广泛的客户成功案例



遍布全国的渠道和就近服务