

High-quality dissimilar material joining of steel and aluminum

Solid-State Resistance Spot Joining: Cold Spot Joining

Vehicle body requirements

- **Lighter bodies** to improve fuel/energy efficiency
 - **Improved collision safety**
- ▶▶ Increasing **multi-materialization**
by using aluminum alloy in certain areas

**Increasing demand for technology to
join steel and aluminum materials**

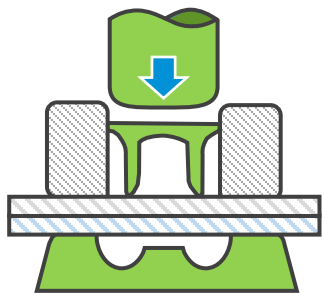


**Examples of applications
involving multi-materials**

■ Steel
■ Aluminum

Dissimilar Material Joining Methods Currently Used or Under Consideration for Automotive Bodies

Rivet joining **indirect** joining

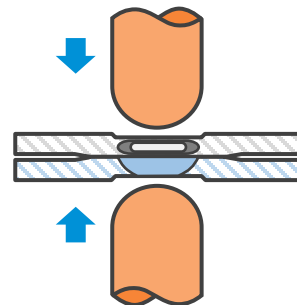


Schematic illustration

Used in practice
for joining steel and aluminum

- Requires rivets (auxiliary material), leading to **increased body weight** and **higher costs**.

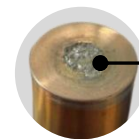
Resistance spot welding **direct** joining



Schematic illustration

At research stage
for joining steel and aluminum

- Non-uniform IMC results in **inconsistent joint quality**.
- Severe electrode wear

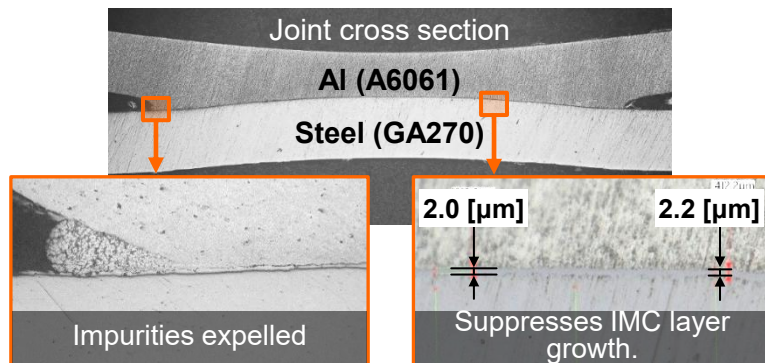


Electrode wear due to alloying with base metal

* IMC: Intermetallic compound. Here it refers to compound formed in iron-aluminum joints.

Daihen's solution: **Solid-Phase Resistance Spot Joining**,
a **direct joining method** to achieve consistent quality for steel-aluminum joints

Advantages of Cold Spot Joining (CSJ) Solid-Phase Resistance Spot Joining



Removes oxide film and other **impurities** formed during joining under **high load**.

Approx. 2.0 μm thin IMC
formed uniformly IMC: Intermetallic compound



CSJ electrode
Steel-aluminum dissimilar material joining
* Patent pending

Redesigned electrode material **minimizes alloying** with base metal.

Significantly reduces electrode wear.

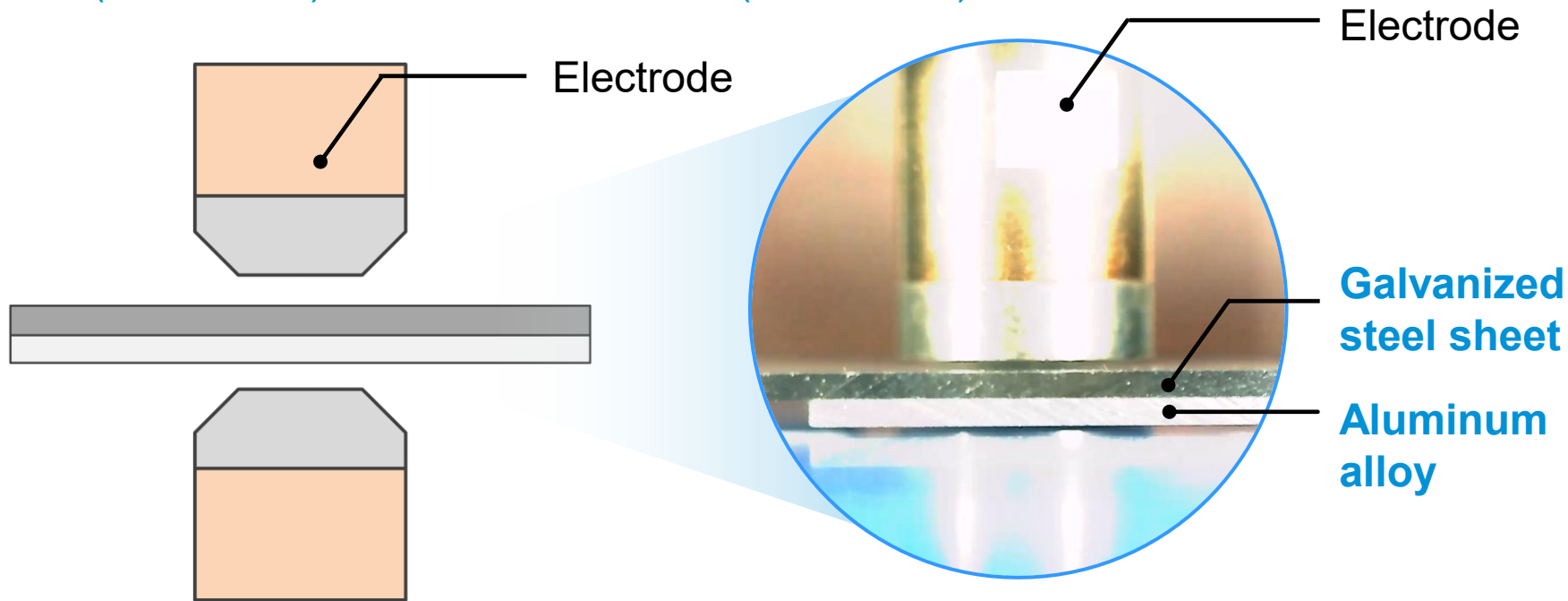
Galvanized steel sheet

GA270 (t = 1.6 mm)

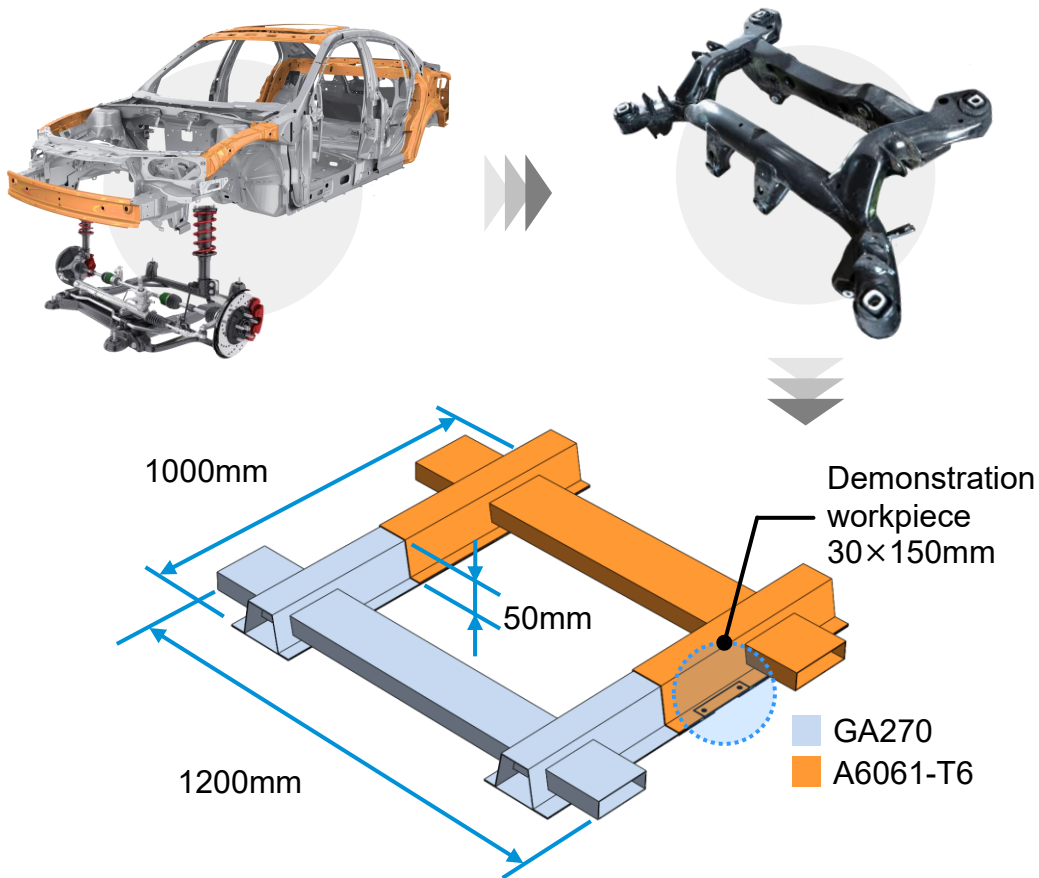


aluminum alloy

A6061 (t = 1.6 mm)



Demonstration: Joining Galvanized Steel Sheet and Aluminum Alloy

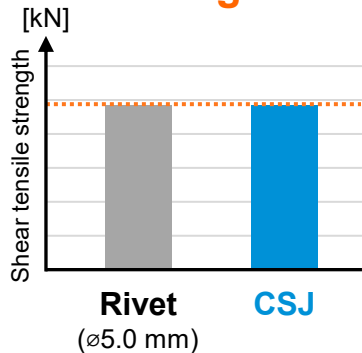


Demonstration conditions

Material	Galvanized steel sheet: GA270 Aluminum alloy: A6061
Thickness	1.6
Joint	Lap joint

Riveting VS CSJ

Comparable joint strength



Results in plug fracture

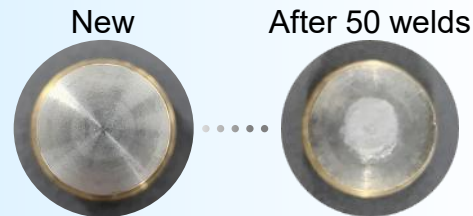


Resistance spot welding VS CSJ

Resistance spot welding
electrode surface



CSJ
electrode surface



CSJ helps ensure consistent quality when joining steel and aluminum.

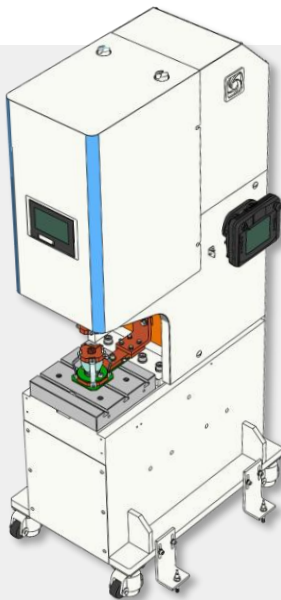
Two Types to Suit Different Applications

Stationary type for preliminary verification of joining method

Gun type for line introduction

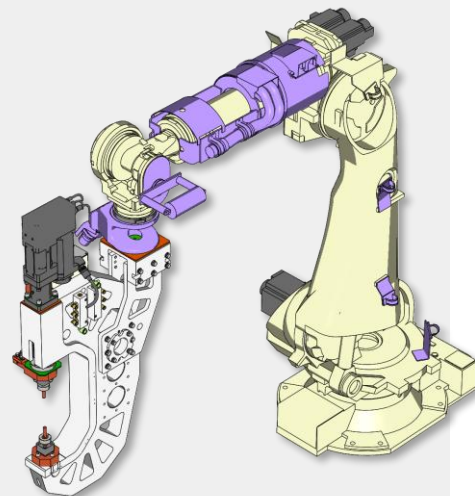
Features of stationary type

- Allows examination of conditions using test pieces.
- Allows easy condition setting using monitor, etc.
- Allows space-saving.



Features of gun type

- Allows incorporation into production line.
- Allows easy condition setting using robot, etc.



**Solid-Phase Resistance Spot Joining
broadens the application scope of
dissimilar material joining.**

DAIHEN