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Mitsubishi Materials' High-performance Plating

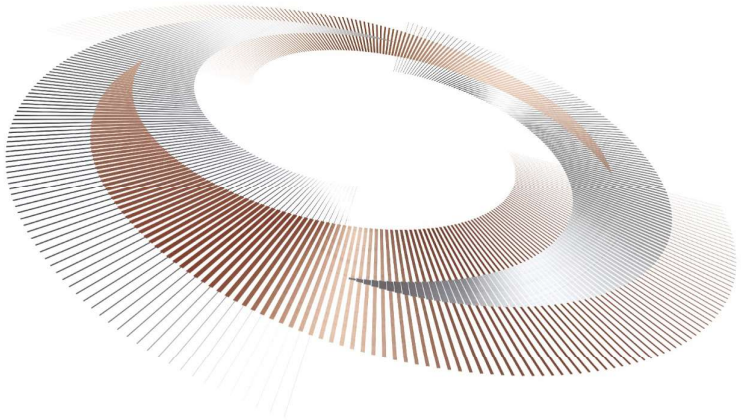
IWCC Technical Seminar | 05-Mar-2025

MITSUBISHI MATERIALS CORPORATION
Advanced Products Company
Copper & Copper Alloy Business Unit
Koya Maeda

IWCC Legal Disclaimer

The purpose of this presentation is to guide programs benefiting the copper industry and to provide attendees with information to make independent business decisions.

Mitsubishi Materials Group's "Our Commitment"



For people, society and the earth, circulating resources for a sustainable future

In order to make careful use of limited resources,
we will give new life to used products as new resources.
We will return these resources to society with new value added.
We will build a platform for this resource circulation and create value as an active player.
As we look to the future, we will make a strong contribution to the creation of a sustainable society,
and help to widen the scope of resource circulation.

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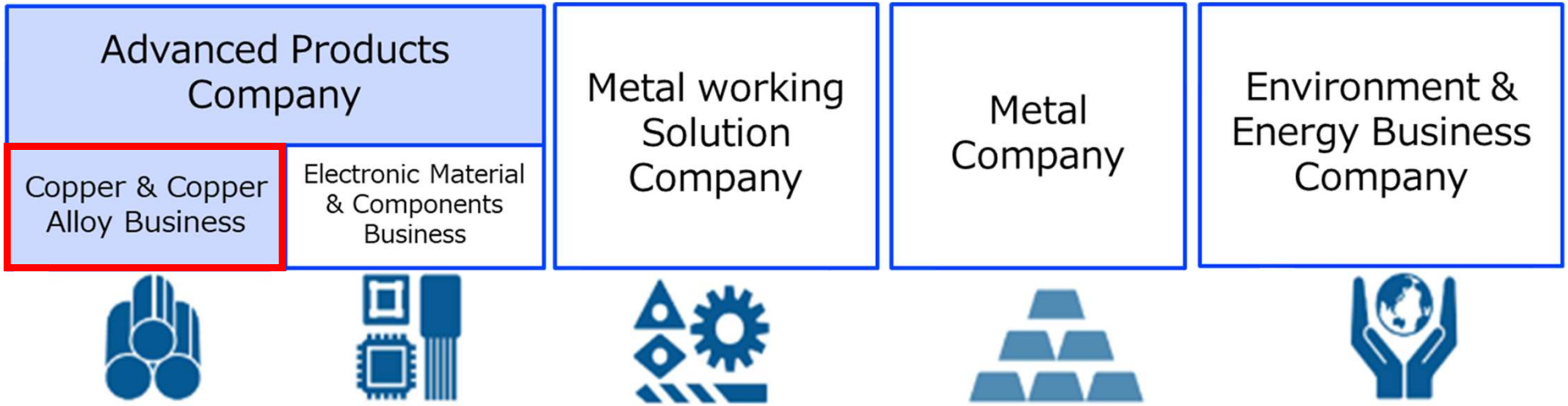
Mitsubishi Materials Corporation

MITSUBISHI MATERIALS



A Group Company of MITSUBISHI MATERIALS

LUVATA

Details
About MMC: http://www.mmc.co.jp/corporate/en/

Copper & Copper Alloy Business

Raw Material

1st Processing

2nd Processing

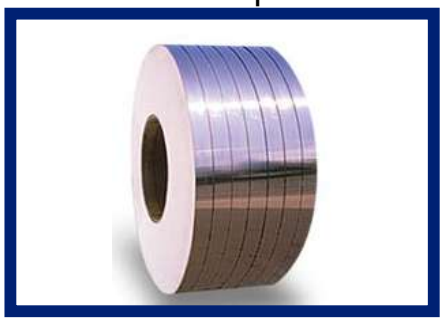
Wakamatsu and Sambo Plants

Electrolytic Copper

Cakes

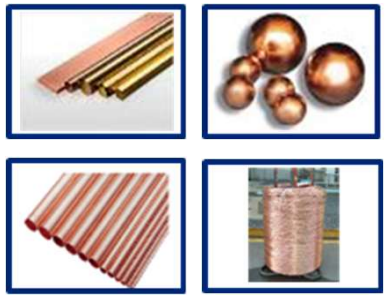
＊Only Rolled Product listed

Strips



Plates

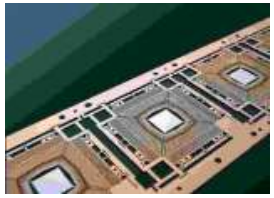
Bars, Anodes, Wires



(Customer Products)

Terminals

Lead frames



Others

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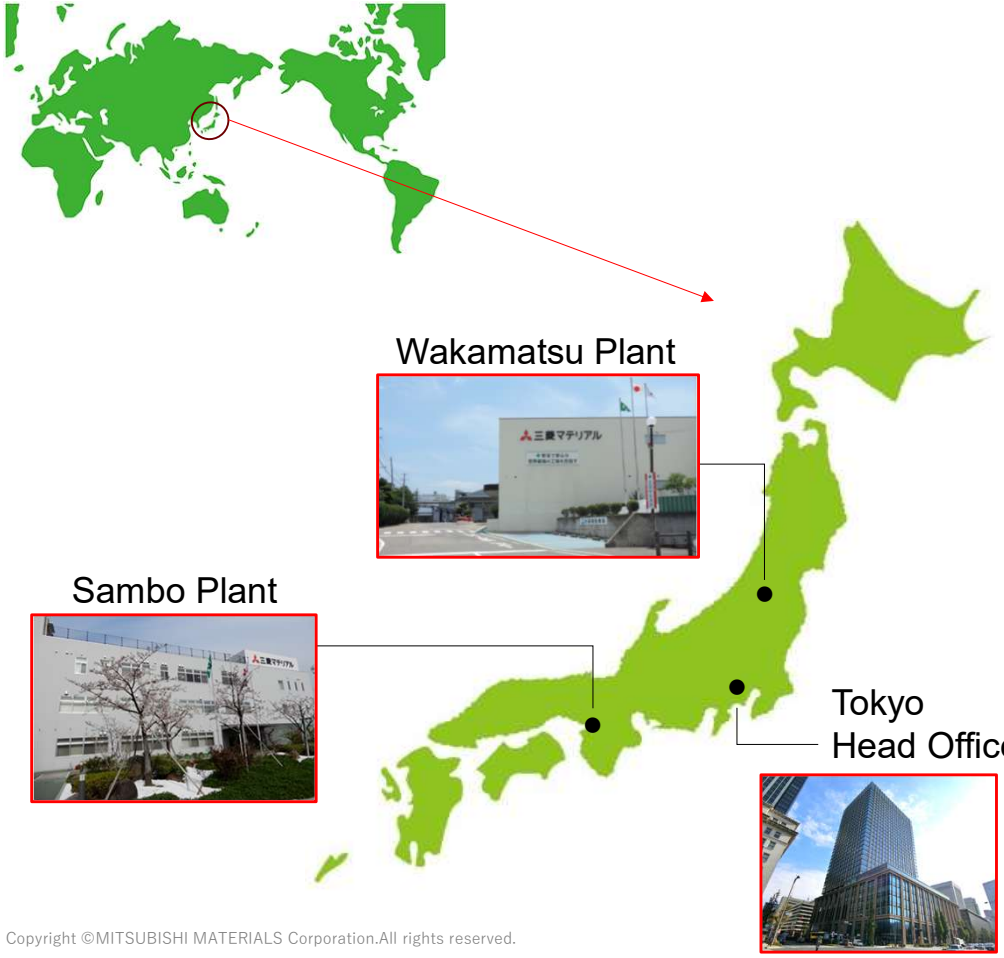
Copper 2nd processing in Japan



Aizu Wakamatsu City, where the Wakamatsu Plant located

Tsuruga-jo Castle

Winter scenery

Products and Applications

【Products】

・Copper Alloy Strip
with **Reflow Sn Plating** (Optional)

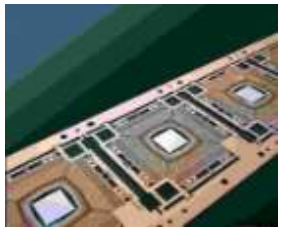
【Application example】

Precision Terminal and Connector

Junction Box

Automotive applications

Automotive Relay



Semiconductor

Light Emitting Diode

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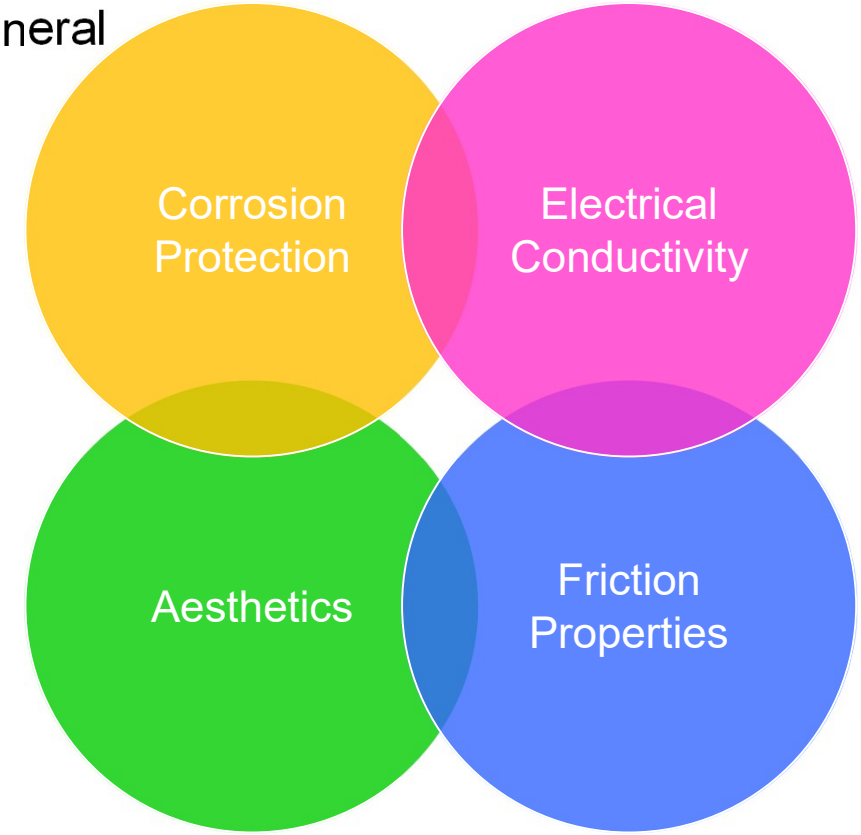
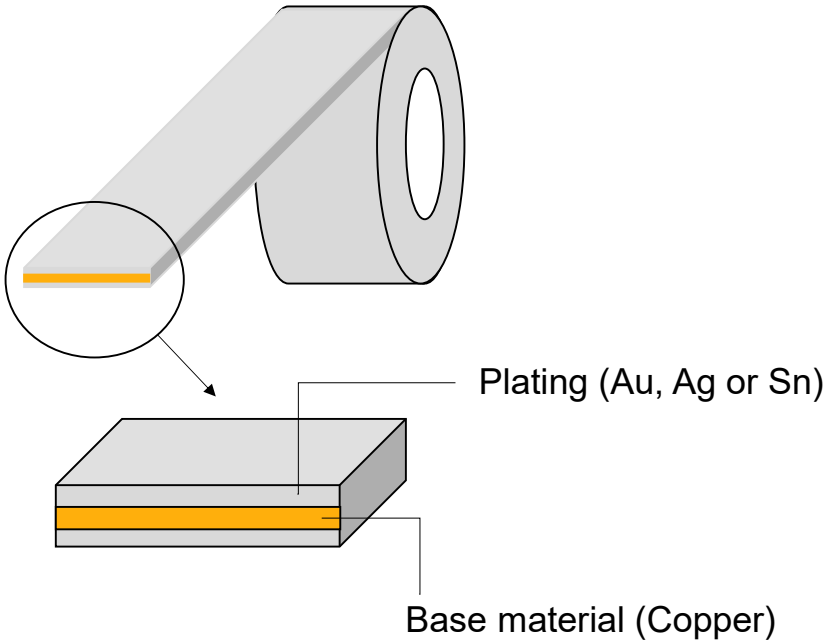
The Functions of Plating

In General

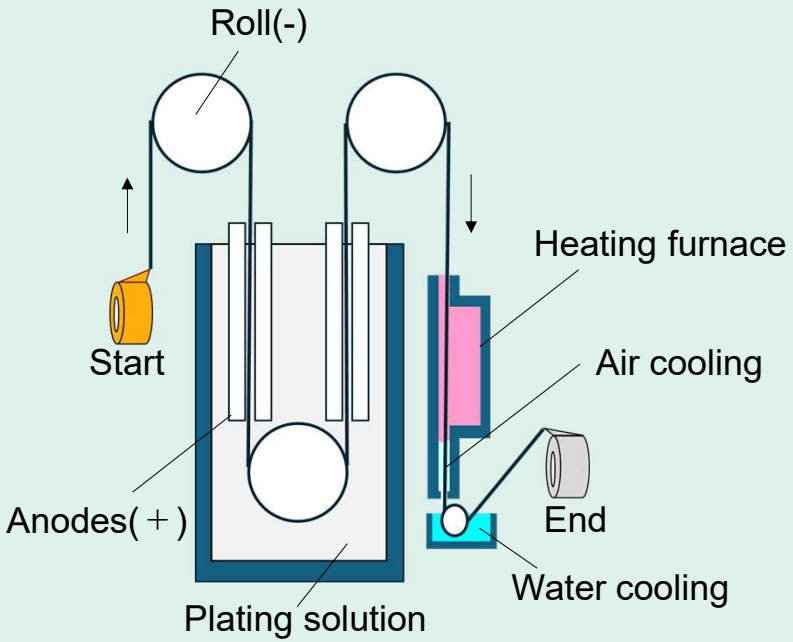


In Automotive use

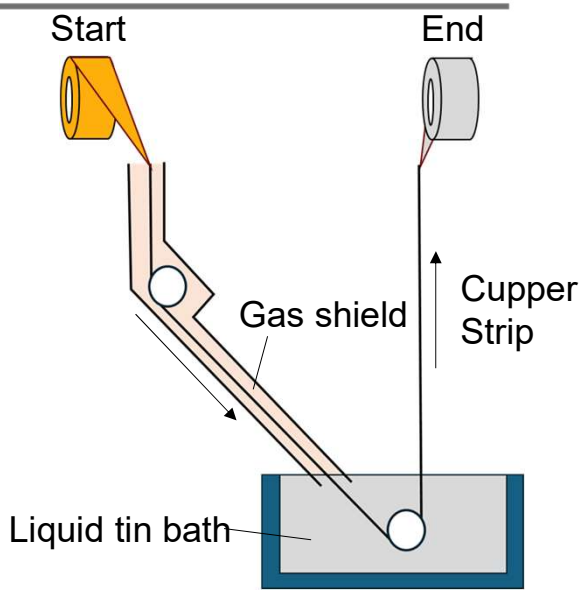


In automotive components, **Au**, **Ag** and **Sn** plating are used **for high Electrical reliability**
Sn plating is often used for its **lower cost**

Overview of Plating equipment



Reflow Sn Plating Line



Hot-dip line
(For comparison)

Reflow Sn plating is superior in terms of **uniform film thickness** and **whisker suppression**

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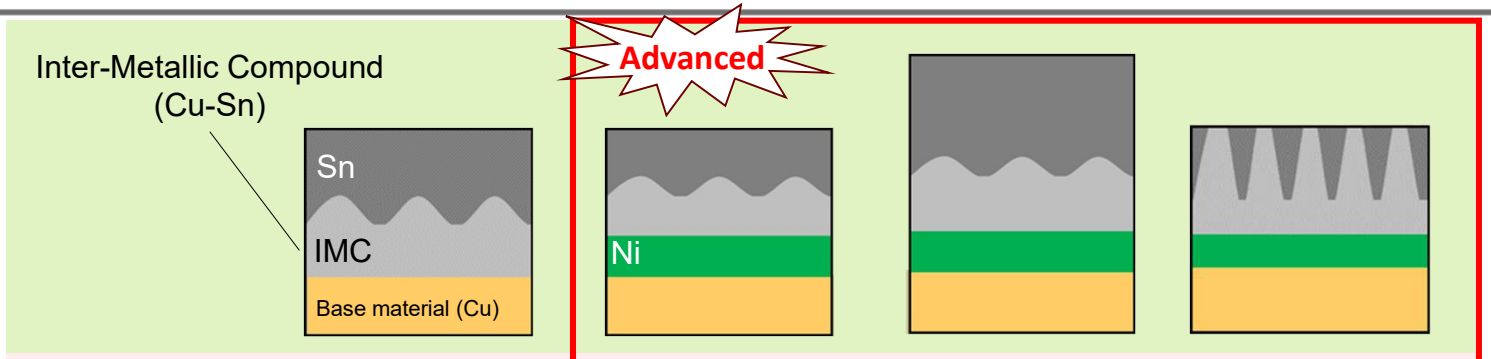
High-performance Plating Line-Up

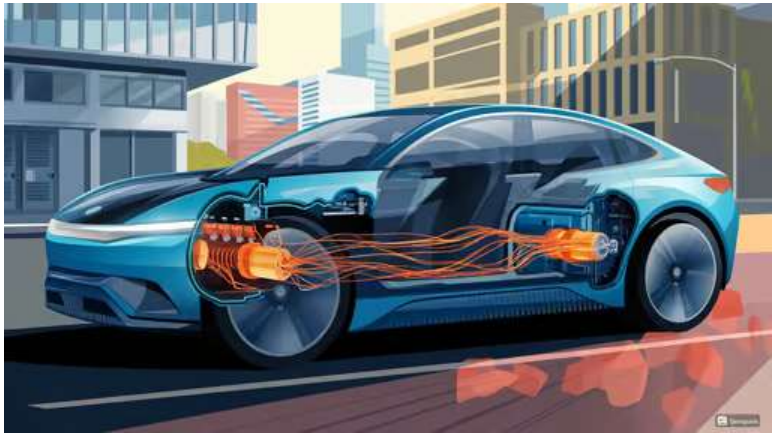


Product name	Conventional plating	Standard Heat-resistant 3-layer plating	Enhanced heat-resistant 3-layer plating	PIC Plating for low insertion force
Heat resistance	○	++	+++	+
Low insertion	○	○	-	+++
Wear resistance	○	○	○	+

Very good +++ Good ++ Slightly good + Neutral ○

We have a lineup of plating with **heat resistance** and **low friction** characteristics

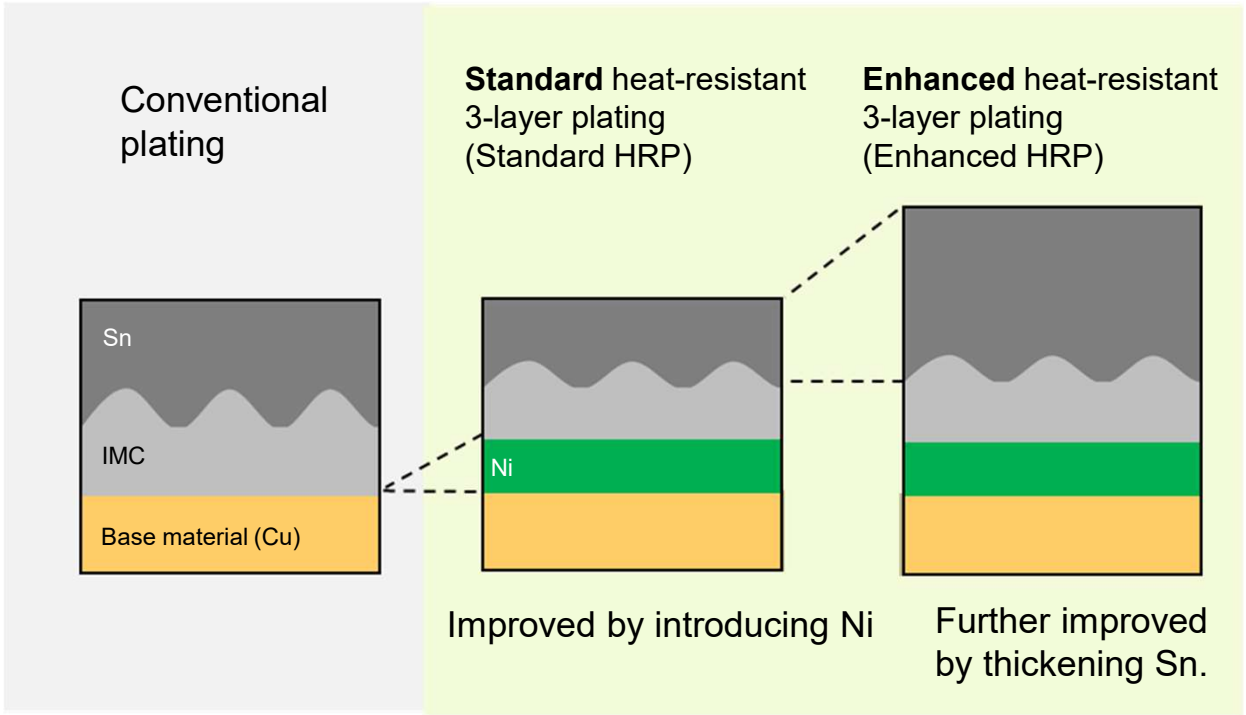
Needs for Heat Resistance in Plating

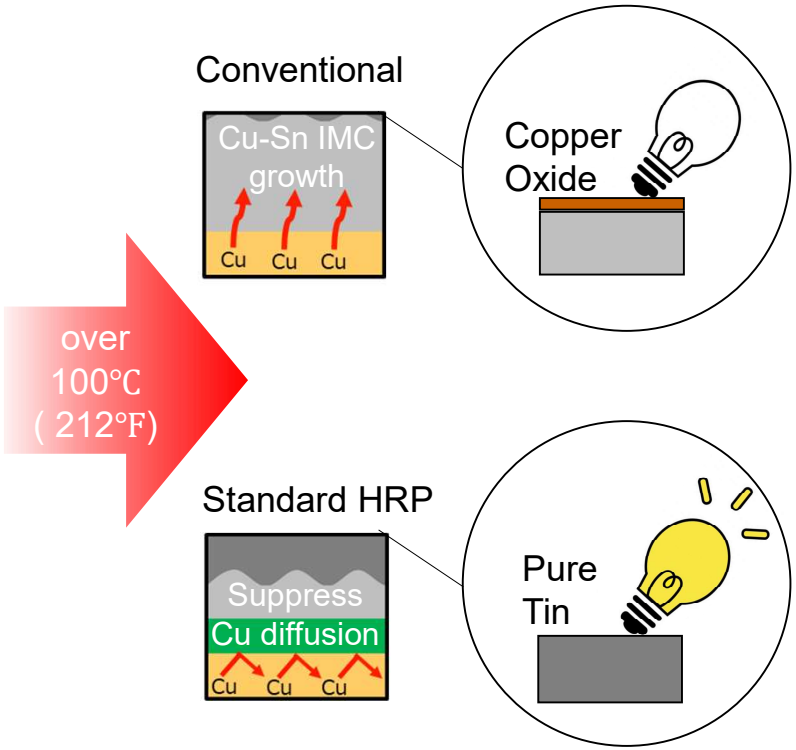


Heat resistance is an issue around automobile **engines** and **motors**

Heat resistance of **100℃(212℉) or higher** is required

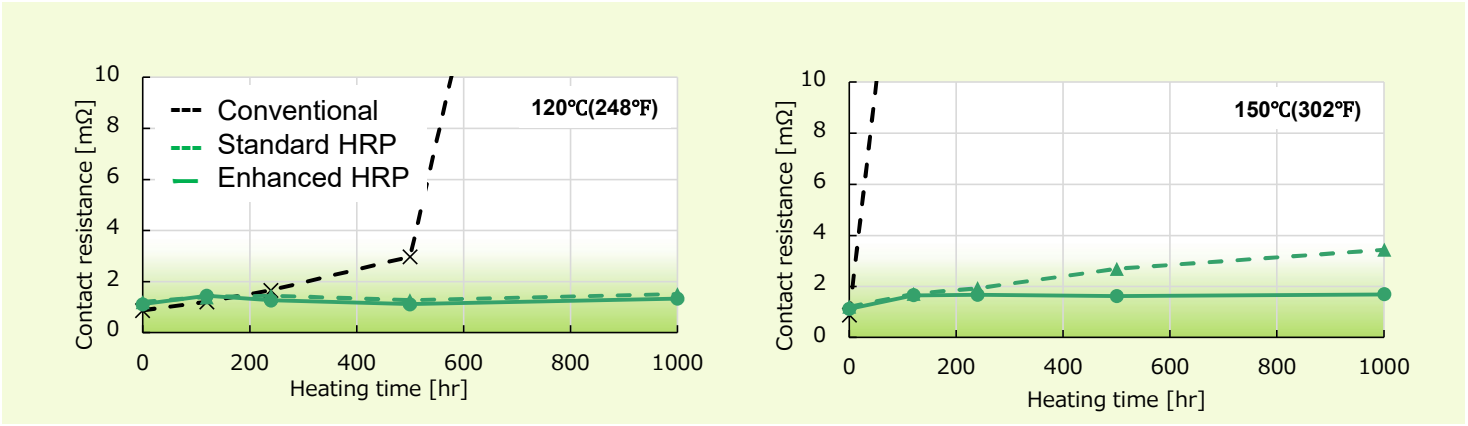
Structure of Heat-resistant 3-layer plating

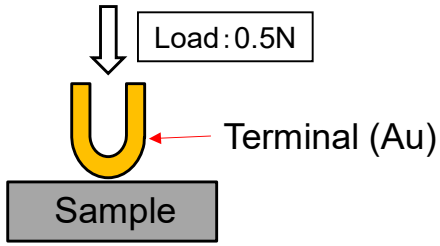




The **introduction of Ni layer** improves heat resistance to **over 100℃(212℉)**

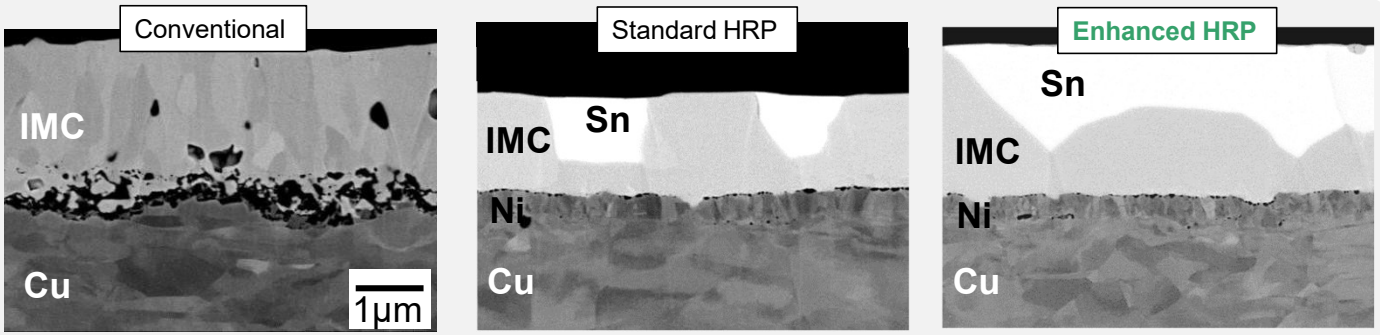
Contact resistance after heating test





Measured without sliding

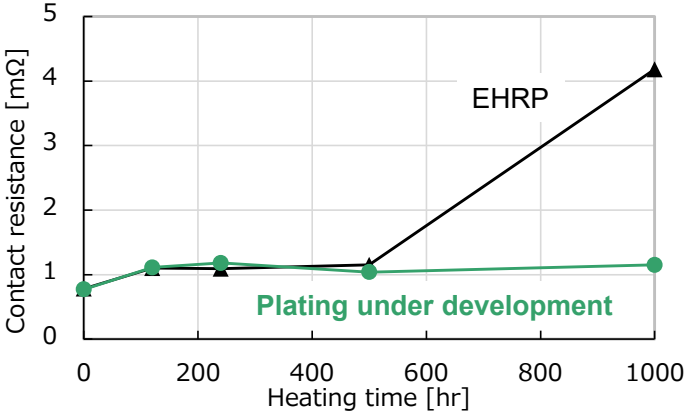
Cross Section after 150℃(302℉), 1000hr heating test

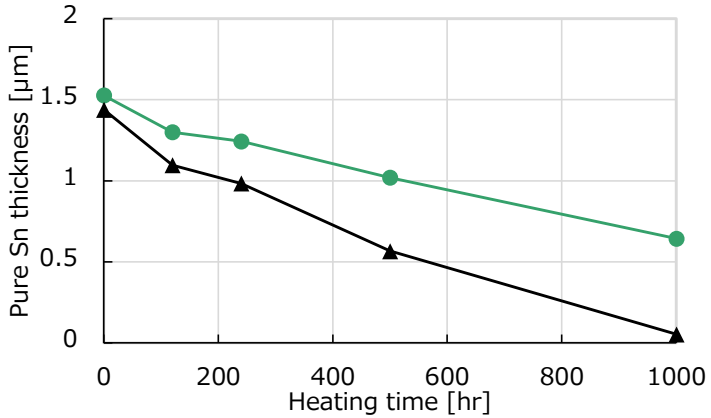


By using **Enhanced HRP**, heat resistance increased to **150℃(302℉)**

Challenge of replacing Ag plating

Contact resistance after 175℃(347℉), 1000hr heating test



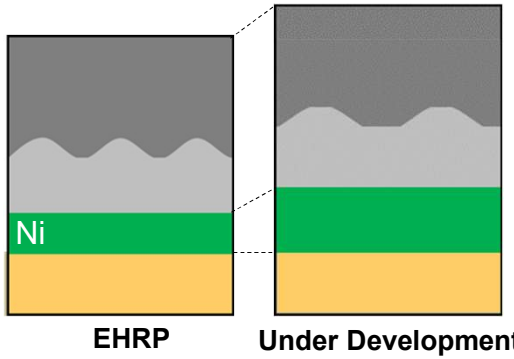


Direction of the solution :

Thickening Ni -> More strongly suppresses copper diffusion

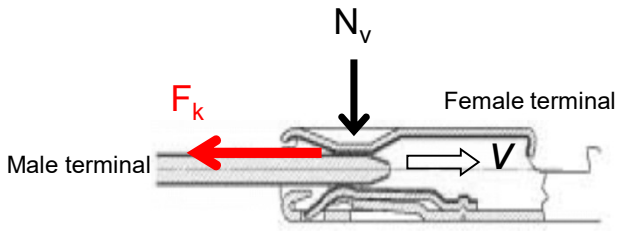
Thickening Sn -> Increase the amount of residual tin

Optimizing IMC Shape -> Suppress reaction between Sn and Ni



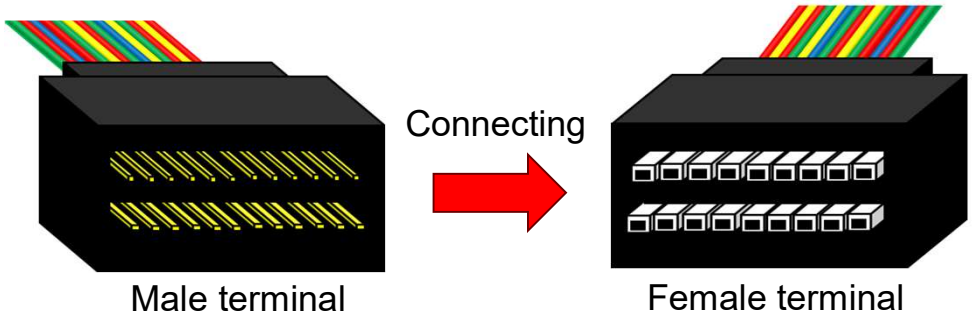
Substantial cost reductions can be expected by **replacing Ag plating with Sn plating**

Needs for low insertion force



$$F_k = \mu_k \cdot N$$

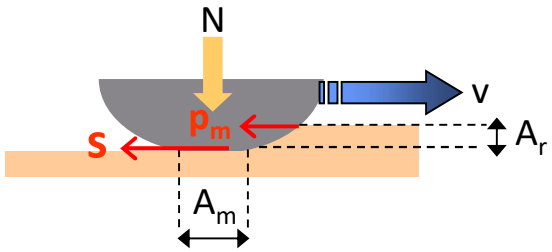
- F_k：Friction force
- μ_k：Friction coefficient
- N：Vertical load



Total Friction force = 2 F_k ・Number of Pins

As the number of pins in a connector increases,
the effort required to connect increases

Mechanism of sliding friction

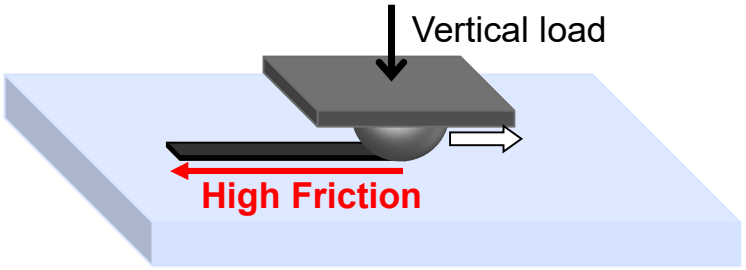


$$F_k = \mu_k \cdot N = (\text{Adhesion}) + (\text{Plunging}) = s \cdot A_m + p_m \cdot A_r$$

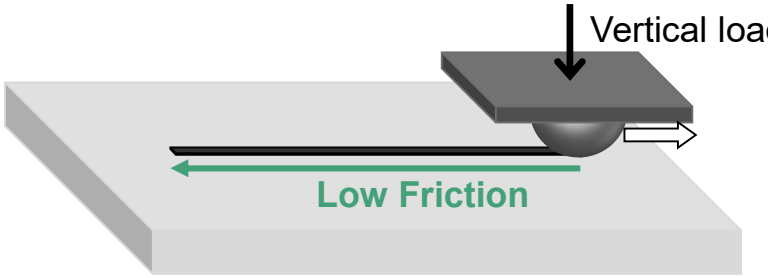
- F_k : Friction force
- μ_k : Friction coefficient
- N : Vertical load
- s : Shear strength
- A_m : Actual contact area ($A_m = N/p_m$)
- p_m : Plastic flow pressure
- A_r: In sliding direction Actual contact area

Adhesion : the resistance breaking the bond between contacting surfaces, considered to be the **main cause of friction**

Plunging : the resistance force removing the contact surface by pushing, having a **large effect on soft tin**

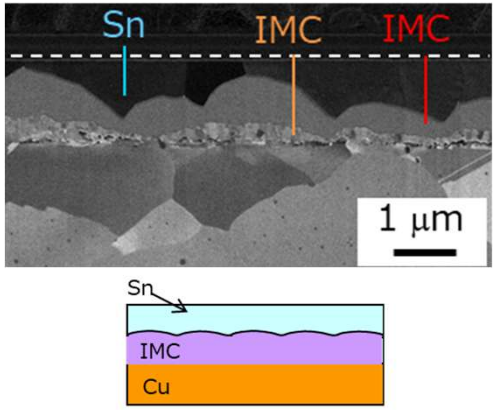
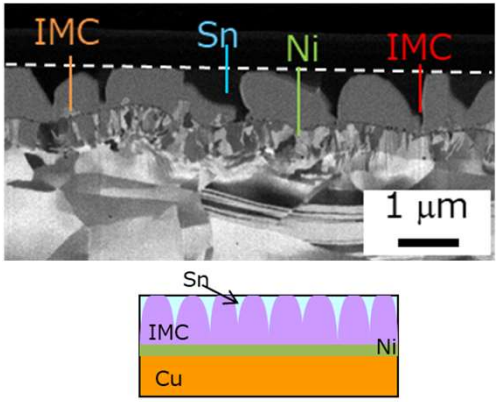
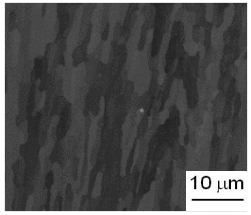
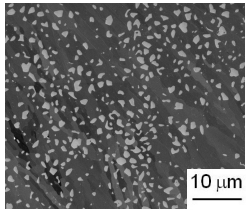


Soft Material (e.g. tin)



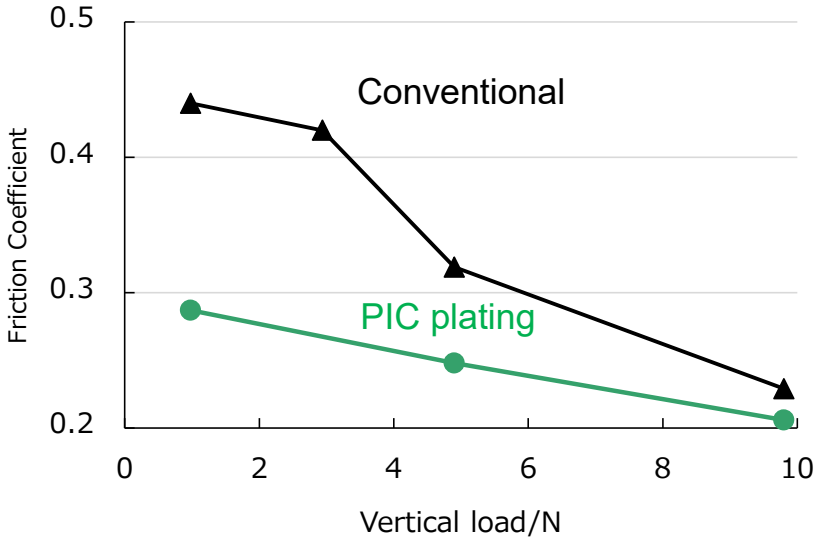
Hard Materials (e.g. IMC)

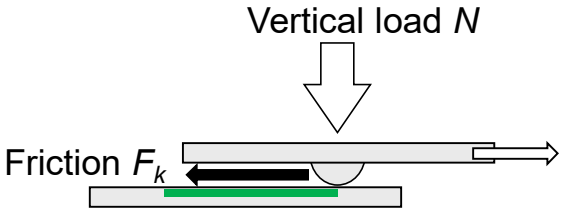
Structure of PIC plating (Tin-plated copper alloy with Precise Interface Control)

	Conventional	PIC plating
Cross sectional views of plated layers (SIM images and schematic diagrams)		
Surface structure Dark portion ：Sn White portion ：IMC		
Area ratio of IMC	Less than a few %	About 20%

By exposing the hard IMC on the plating surface at an appropriate ratio, **friction is reduced**

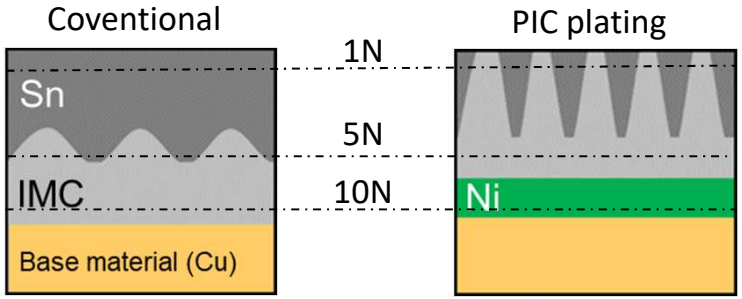
Load dependance of Friction coefficient





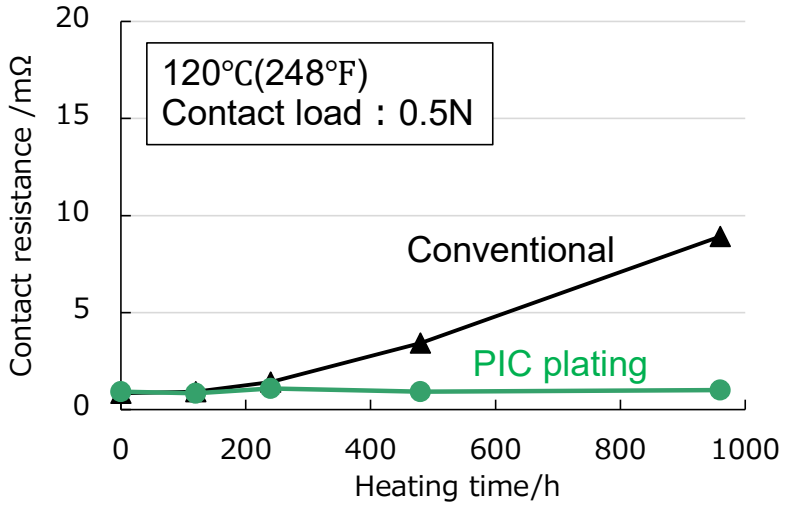
Friction Coefficient $\mu_k = F_k / N$

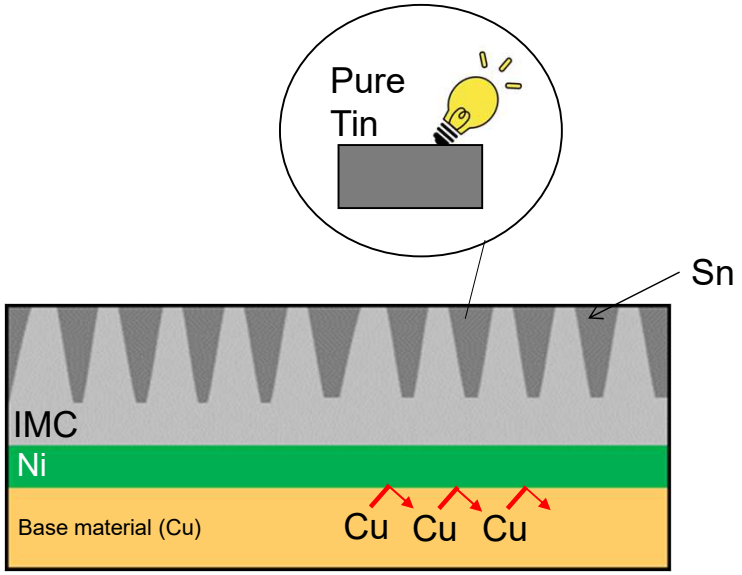
Depth affects friction



PIC has a remarkable effect of reducing friction **in the low load range**, reducing friction **by up to 30%**

Heat resistance of PIC Plating





A certain percentage of surface Sn continues to remain.

PIC plating also has heat resistance of **over 100℃(212℉)** due to the introduction of a Ni layer

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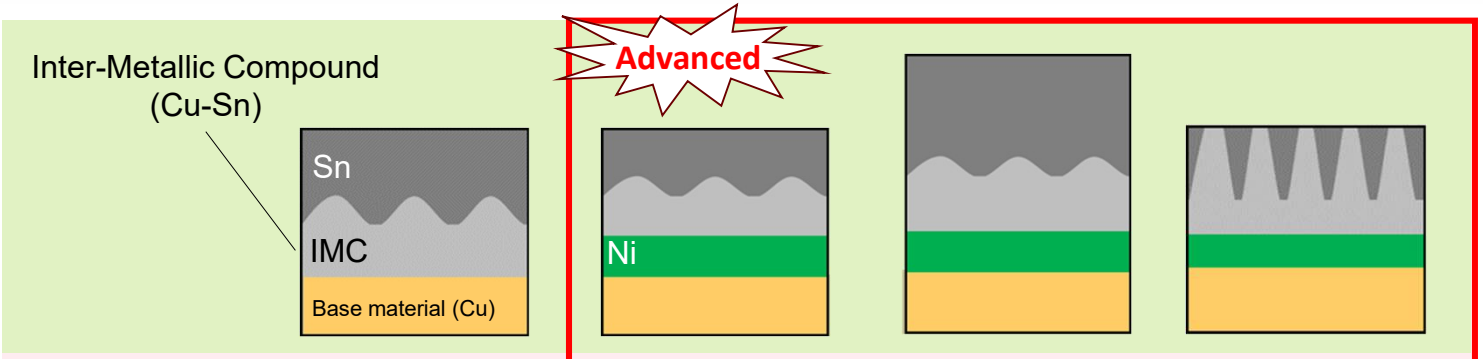
Summary of High-performance Plating



Product name	Conventional plating	Standard Heat-resistant 3-layer plating	Enhanced heat-resistant 3-layer plating	PIC Plating for low insertion force
Heat resistance	◯	++	+++	+
Low insertion	◯	◯	-	+++
Wear resistance	◯	◯	◯	+

Very good +++ Good ++ Slightly good + Neutral ◯

Various types of **heat-resistant** and **low insertion** plating required for connectors are available

Thank you for your attention !

If you have any queries, please contact us

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