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# RRR and thickness measurements of Cu plating

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# Background

## Material for Input coupler

- Low thermal conductivity is required to suppress heat transfer from outside of cryostat.
- High electric conductivity (i.e. low resistance) is required to suppress RF resistance.



Very thin copper plated SUS (0.8mm)

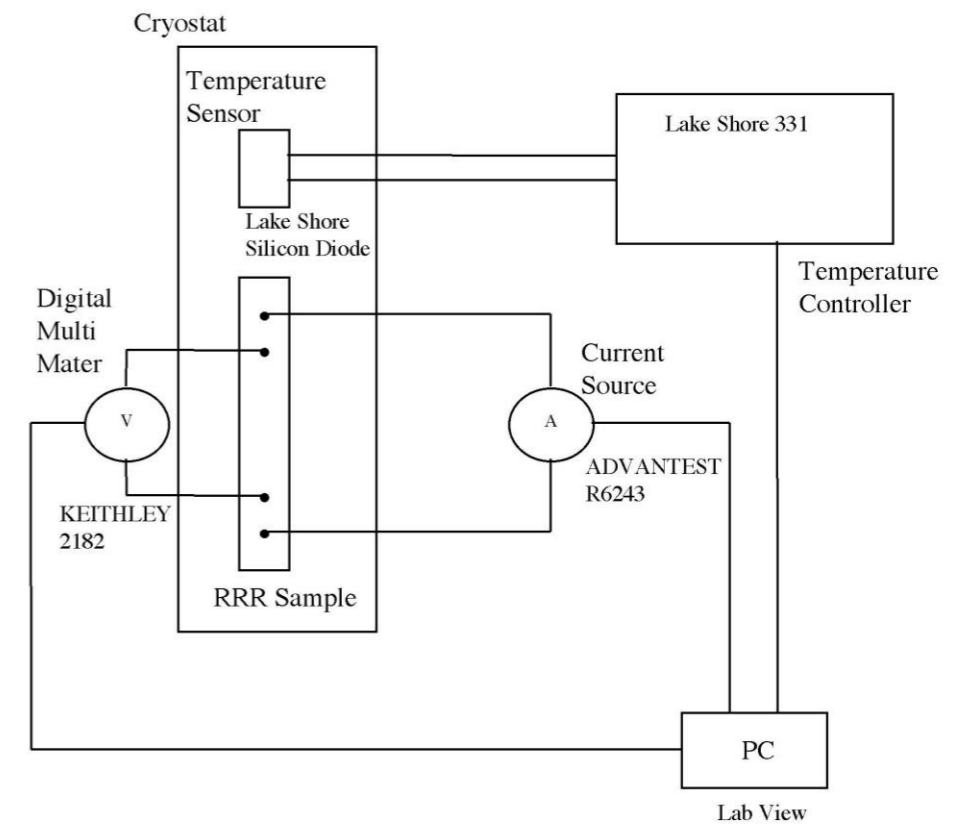


Evaluation of electric conductivity and thermal conductivity of the cu plating is necessary.



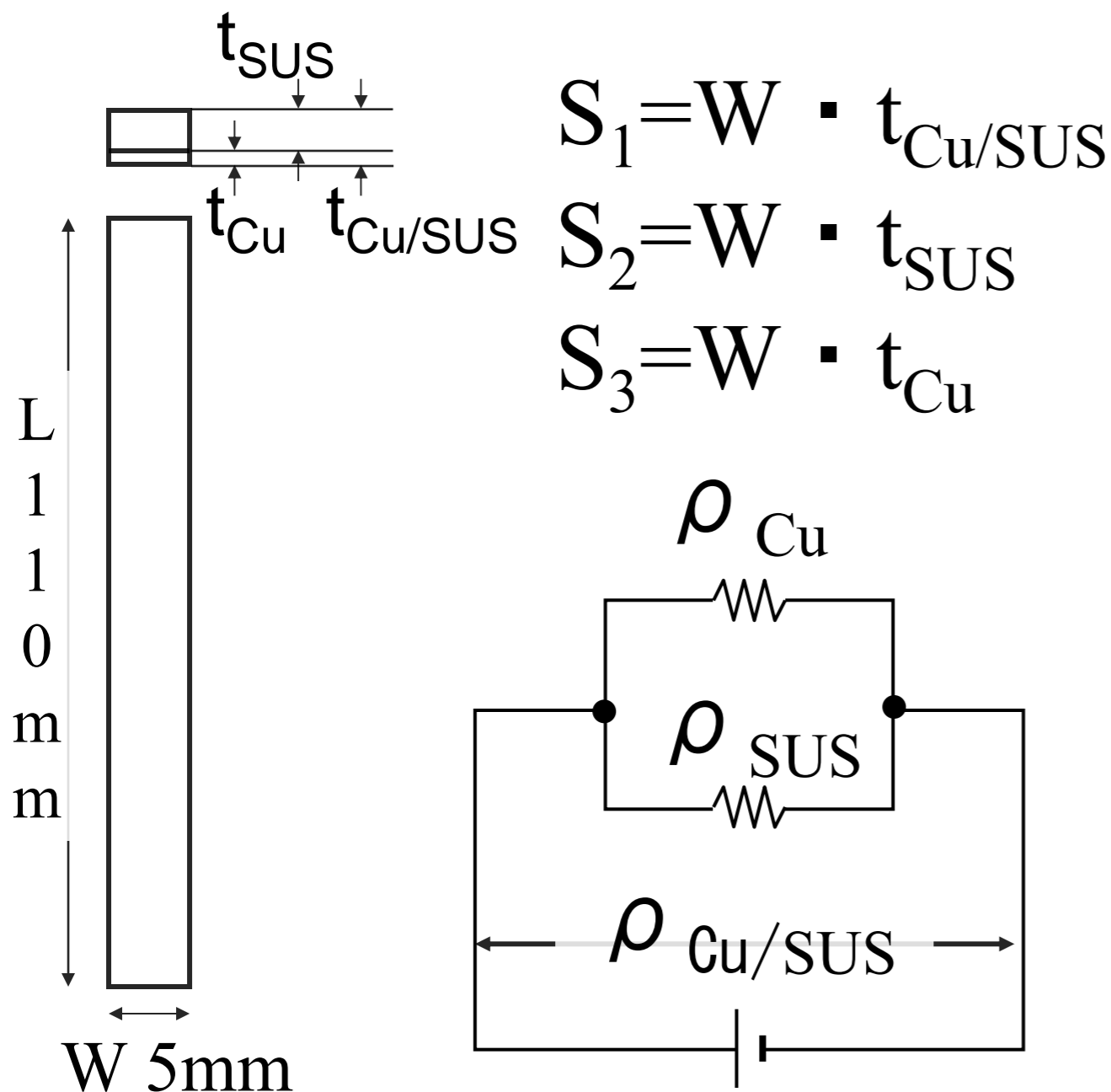
RRR measurement of Cu plating (Target value 30-60)

# RRR Measurement System



# How to calculate RRR of the Cu plating

$$RRR = \frac{\rho_{293K}}{\rho_{10K}}$$



$$\frac{1}{R_{Cu/SUS}} = \frac{1}{R_{Cu}} + \frac{1}{R_{SUS}}$$

$$\frac{1}{\rho_{Cu/SUS} \cdot \frac{l}{S_1}} = \frac{1}{\rho_{Cu} \cdot \frac{l}{S_3}} + \frac{1}{\rho_{SUS} \cdot \frac{l}{S_2}}$$

$$\frac{S_1}{\rho_{Cu/SUS}} = \frac{S_3}{\rho_{Cu}} + \frac{S_2}{\rho_{SUS}}$$

$$\frac{S_3}{\rho_{Cu}} = \frac{S_1}{\rho_{Cu/SUS}} - \frac{S_2}{\rho_{SUS}}$$

$$\rho_{Cu} = \frac{S_3}{\frac{S_1}{\rho_{Cu/SUS}} - \frac{S_2}{\rho_{SUS}}}$$

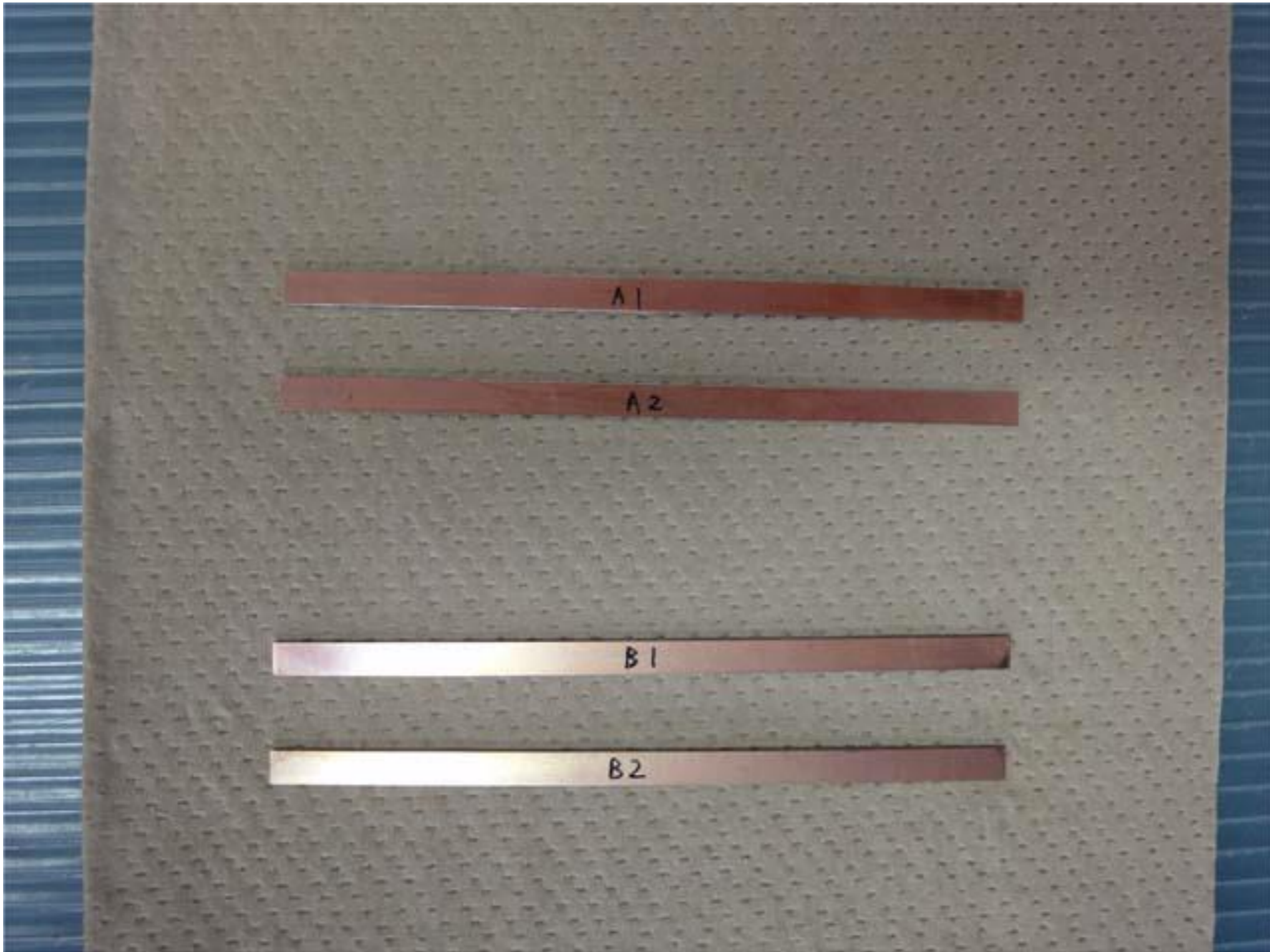
# Sample preparation

- During the input coupler production, heat history of 800C will be added in hydrogen atmosphere due to the brazing.
- To research the influence of this **heat treatment(HT)**, we prepared 2 types of samples which are heat treated and not heat treated. #Simulation of brazing condition.
- 3 samples from each types are prepared, 2 samples for RRR measurement, 1 sample for Cu plating thickness measurement.

# Sample

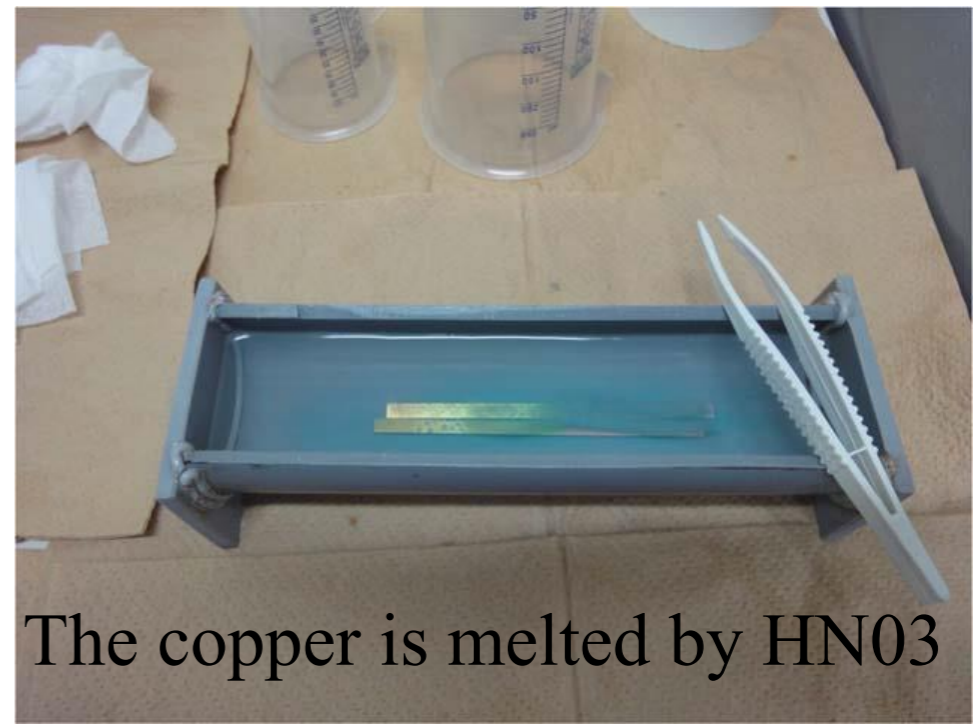
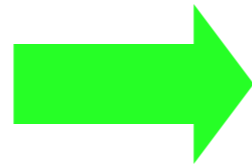
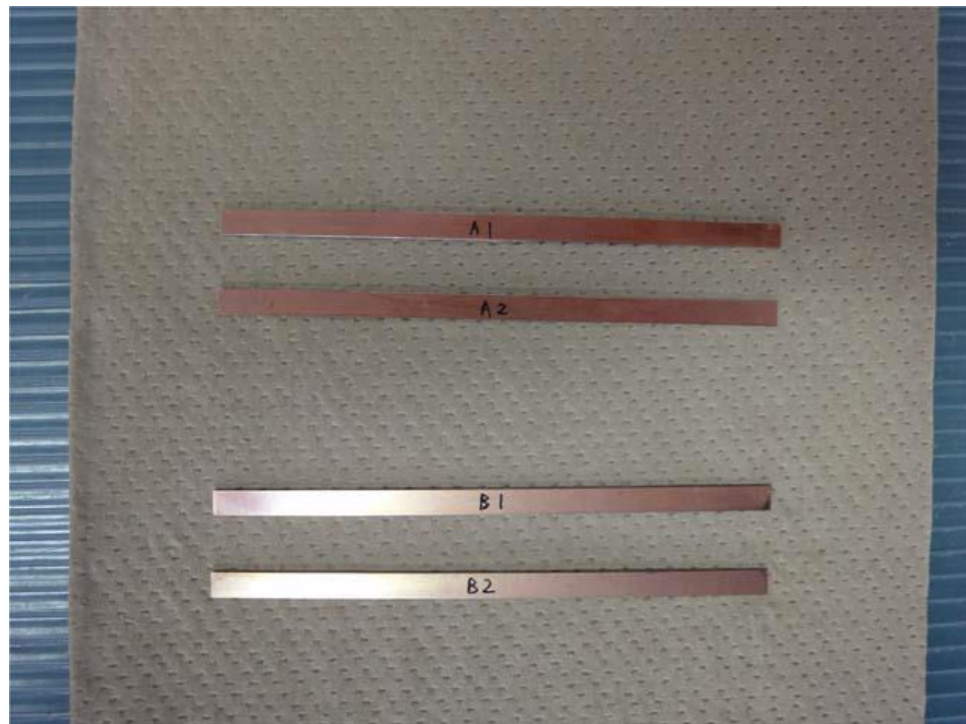
Sample No.		Plating Vender	Condition of Cu Plating	
Before HT	After HT		Thickness of Cu Plating	Plating Method
A1,2,3	A4,5,6	A	Au Strike + Cu 5.2 um	Copper pyrophosphate Plating
B1,2,3	B4,5,6	A	Au Strike + Cu 19.2 um	Copper pyrophosphate Plating
C1,2,3	C4,5,6	A	Ni Strike + Cu 5.4 um	Copper pyrophosphate Plating
D1,2,3	D4,5,6	A	Ni Strike + Cu 20.6 um	Copper pyrophosphate Plating
E1,2,3	E4,5,6	B	Ni Strike + Cu 5 um	Copper Cyanide Plating
F1,2,3	F4,5,6	B	Ni Strike + Cu 20 um	Copper Cyanide Plating
G1,2,3	G4,5,6	C	Ni Strike + Cu 11.7 um	Copper Cyanide Plating
H1,2,3	H4,5,6	C	Ni Strike + Cu 35 um	Copper Cyanide Plating

# Sample

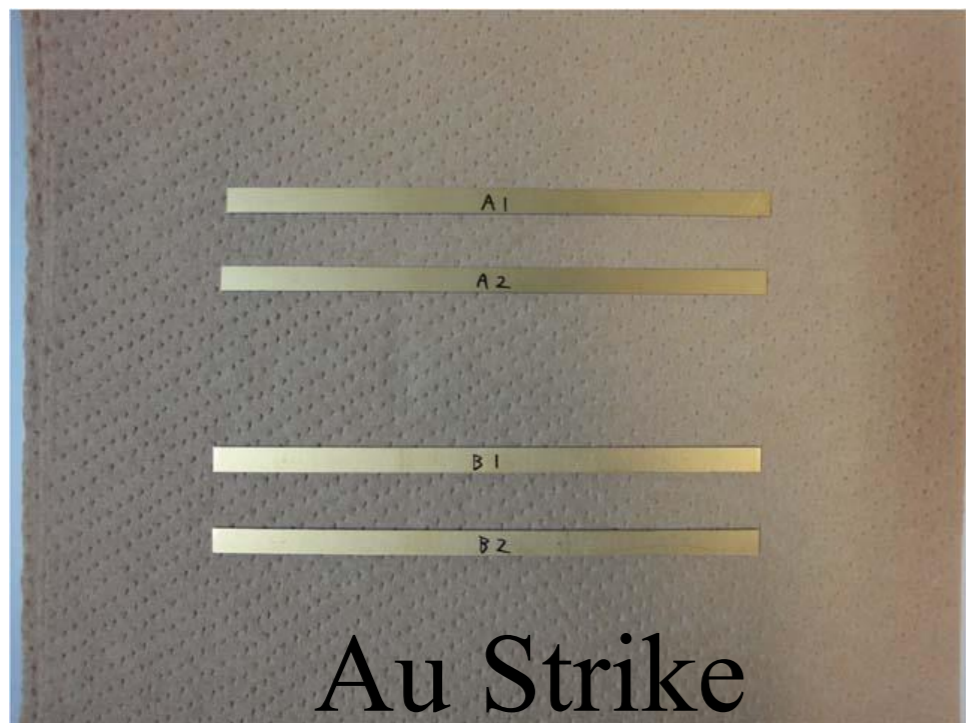
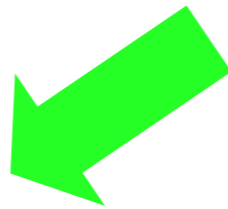




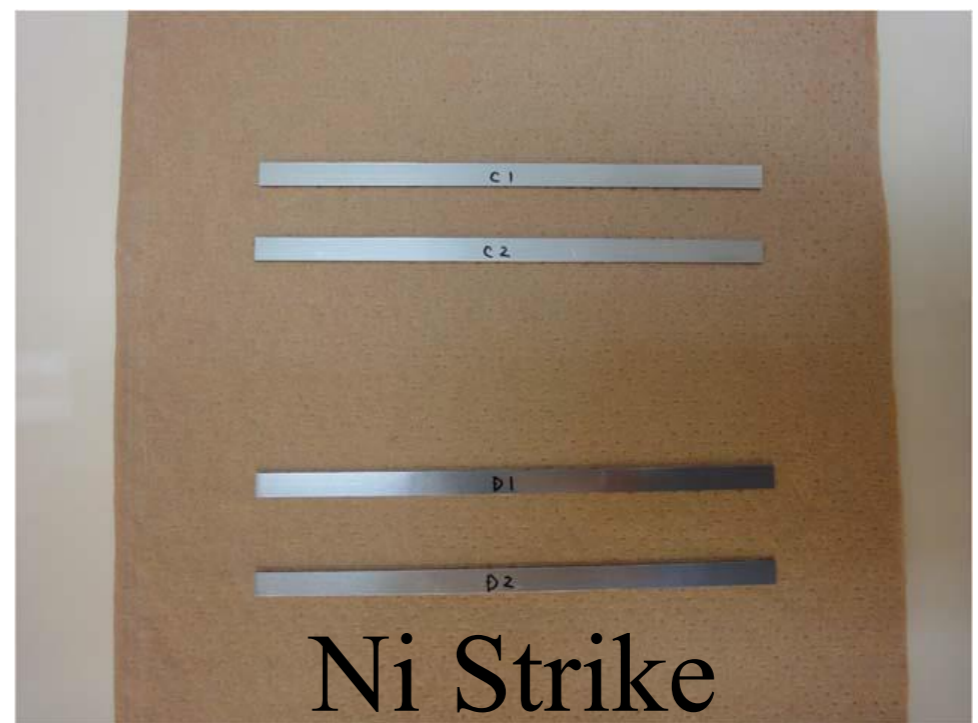
# Cu remove



The copper is melted by  $\text{HN03}$



Au Strike

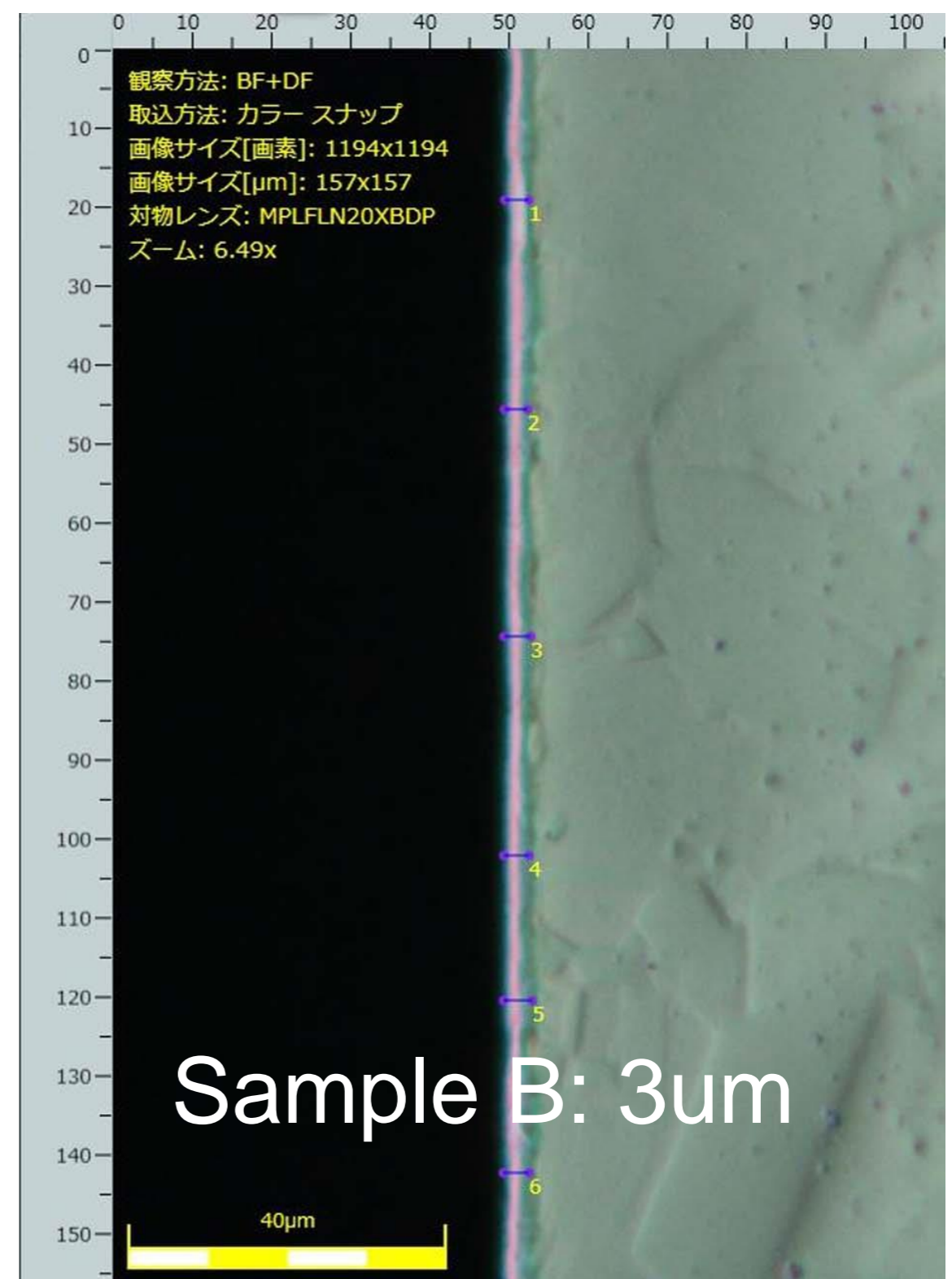
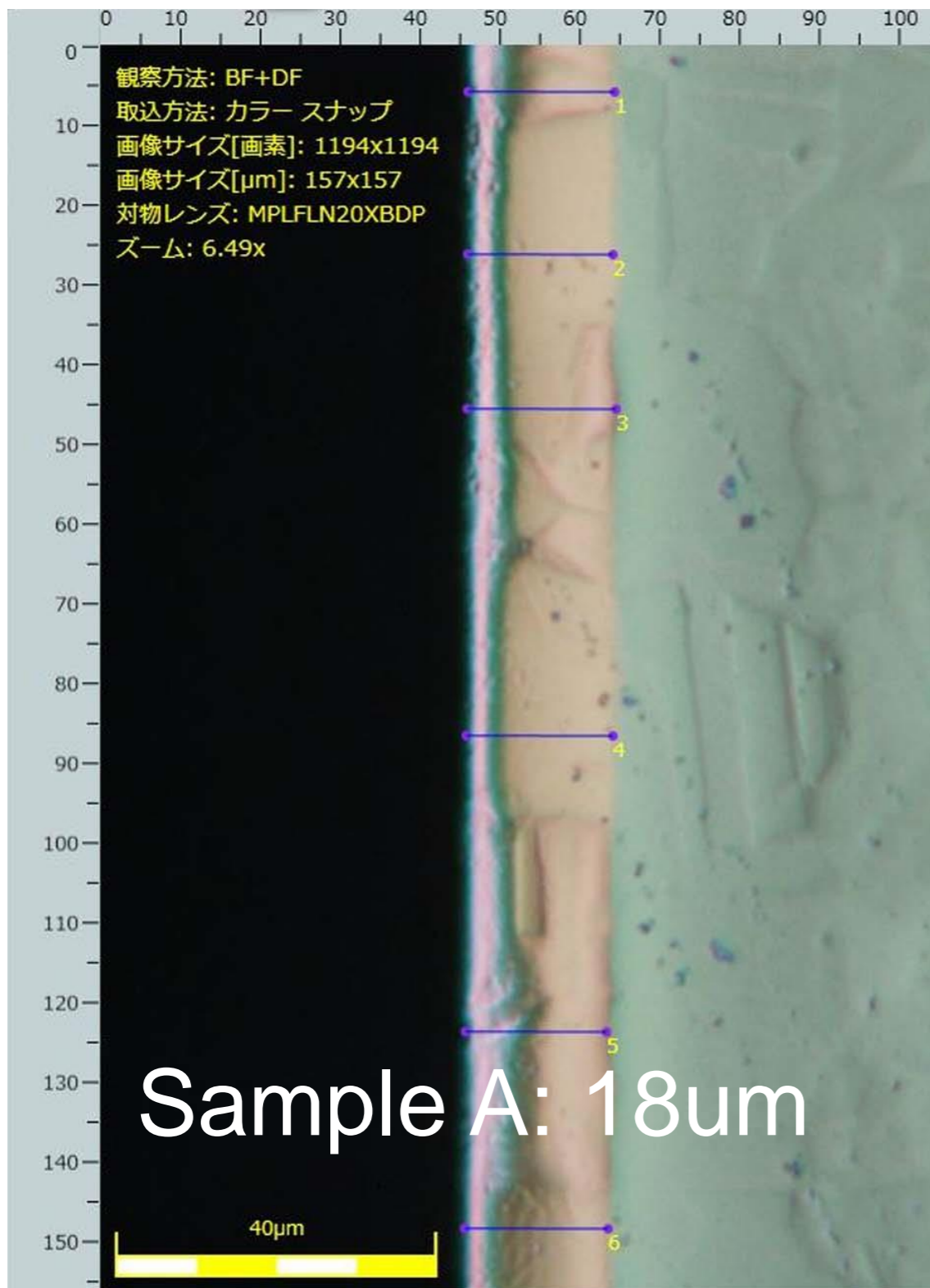


Ni Strike

# Digital Micro Scope



# Plating Thickness Measurement

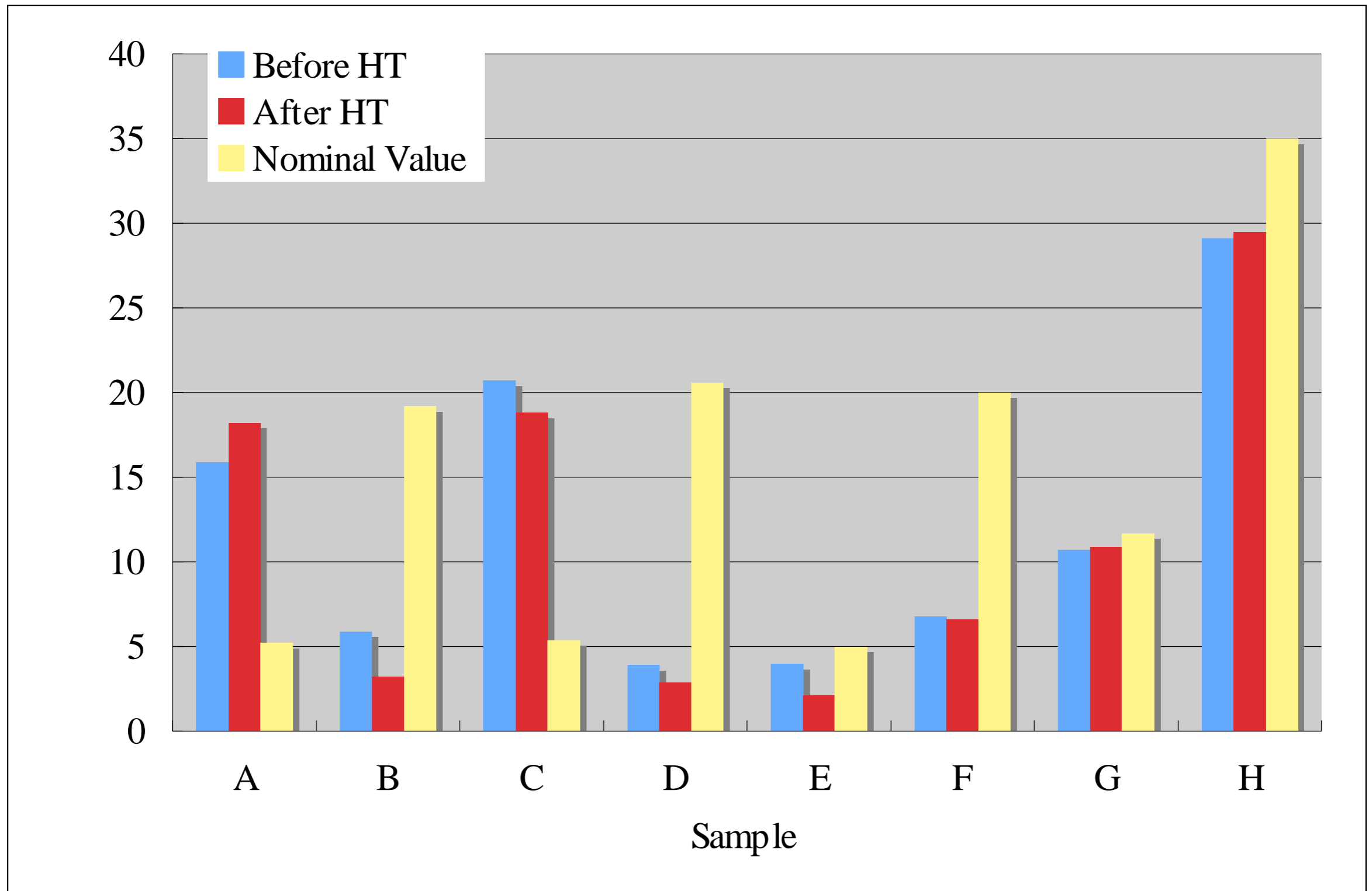


# Measurement Result of Plating Thickness

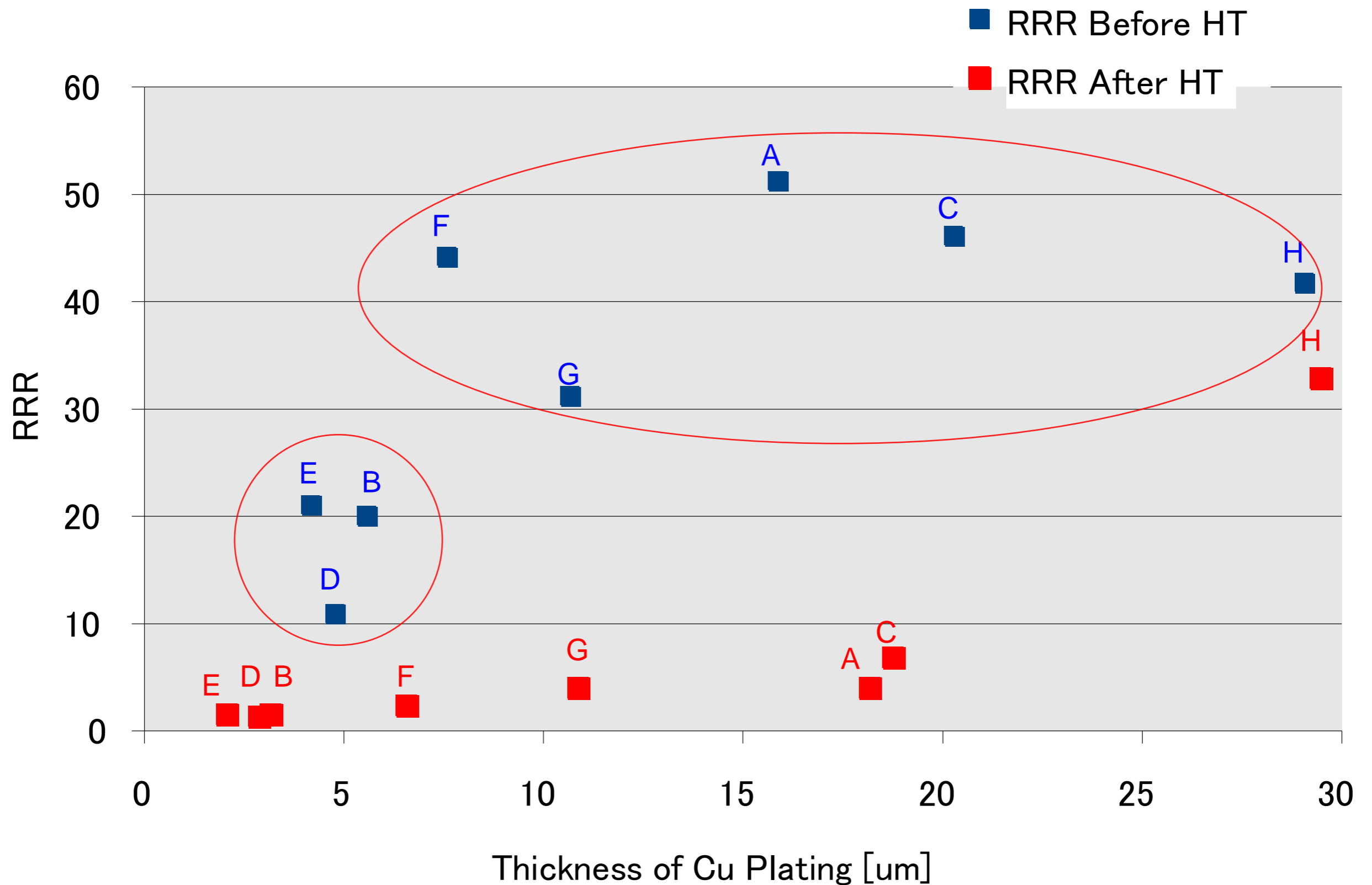
Sample	Vender Report	Measured by Microscope	
		Before HT	After HT
A	5.2	15.9	18.2
B	19.2	5.9	3.2
C	5.4	20.7	18.8
D	20.6	3.9	2.9
E	5.0	4.0	2.1
F	20.0	6.8	6.6
G	11.7	10.7	10.9
H	35.0	29.1	29.5

(um)

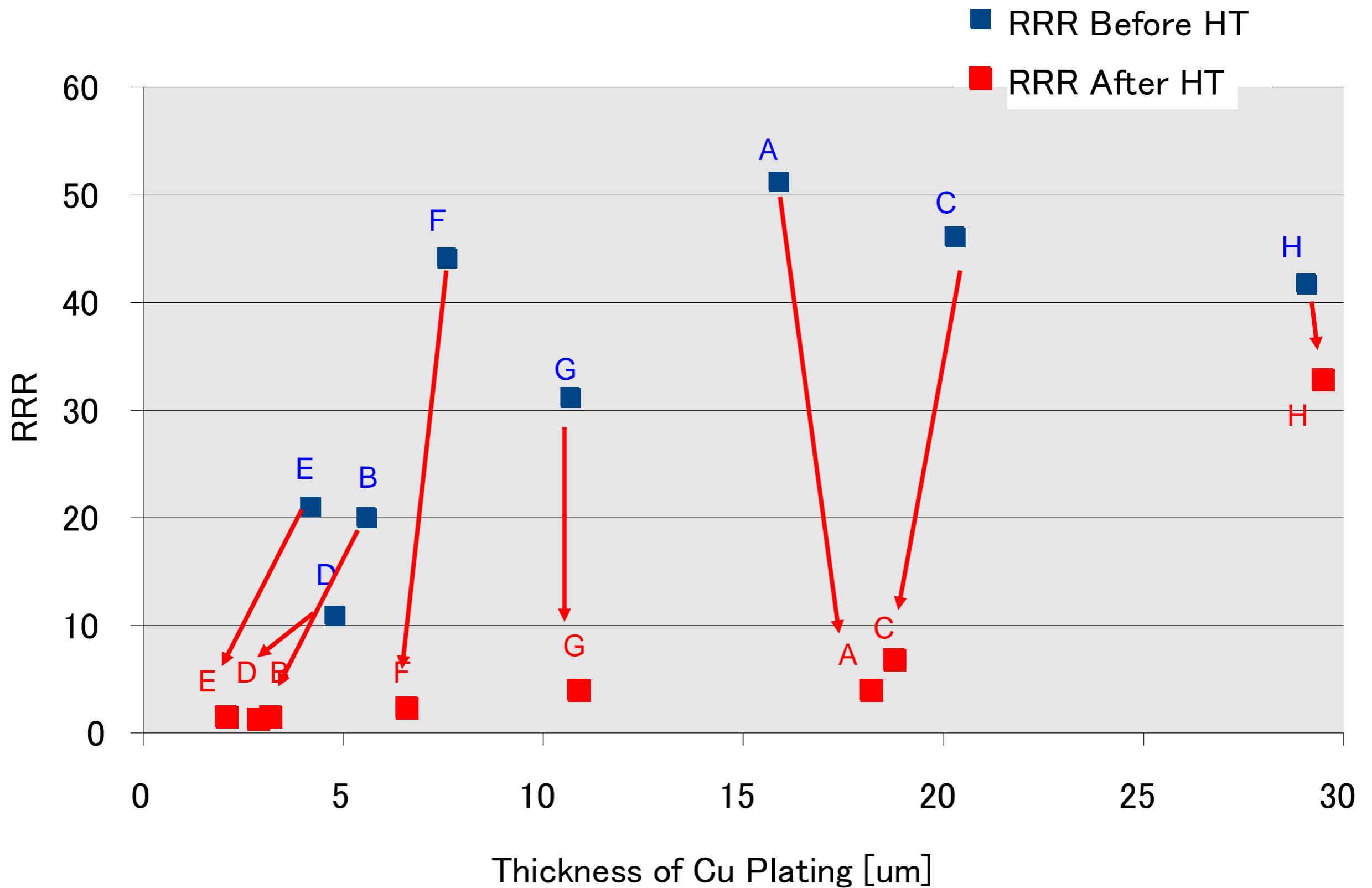
# Thickness of Cu Plating



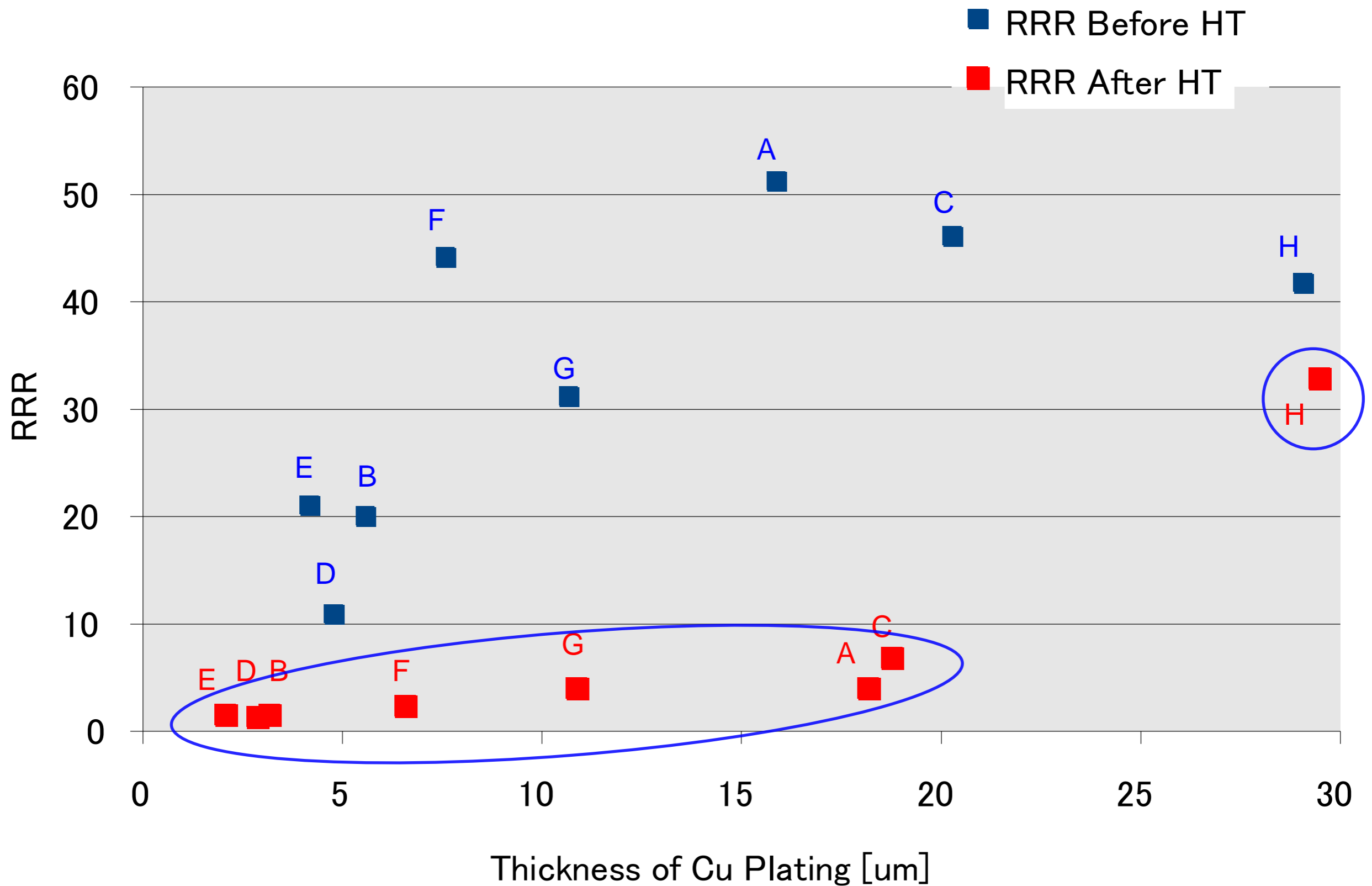
# RRR Measurement Result



# RRR Measurement Result



# RRR Measurement Result





# Conclusion

- RRR measurement and Cu plating thickness measurement of SUS used for material of input coupler of SC Cavity was done.
- There is a difference between measured plating thickness by us and nominal plating thickness by plating vender.
- To get high RRR, plating thickness is important.
- 800C heat treatment exert a negative effect on RRR of plating.
- To overcome the bad influence from heat treatment, thickness of the plating must have at least 30 micrometer.