Stress corrosion cracking (SCC) test method of Cu-Zn alloy for quantitative evaluation

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Technology & Innovation Center
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IWCC Legal Disclaimer

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

1. Introduction
   - Data of the YKK Group
   - Main products in YKK
   - Production process of brass zipper in YKK
   - Objective

2. Experimental Procedure

3. Results and Discussion
   - Color Measurement
   - Microstructure Observation
   - SCC Test

4. Conclusion

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Data of the YKK Group

- Number of Affiliated Companies :
  70 countries / regions　112 companies
- Sales ：920.2 billion yen（FY2023 Actual）
- Number of Employee：45,363　（Japan　18,068、Overseas 27,295）(As of March 31, 2024)

YKK Corporation		YKK AP Inc.
January 1, 1934	Foundation	July 22, 1957
379.3 billion yen	Sales	538.1 billion yen
26,696	Number of Employee	17,834
※Fiscal Year 2023		※Fiscal Year 2023

Main products in YKK Corporation

SLIDE FASTENER

Metal Slide Fastener

Plastic Slide Fastener

TEXTILE&PLASTIC PRODUCTS

SNAP FASTENER AND BUTTON

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Our products have a wide range of applications

Space suits

water controls

Bag/Shoes

Industrial Materials etc.

Fastening Products Group

Casual/ Sports/ Outdoor Apparel

Automotives

Snap & Button/ Hook & Loop/ Plastic Hardware

50 times wrap!

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Production process of Metal Slide Fastener in YKK


Copper


Zinc


scraps

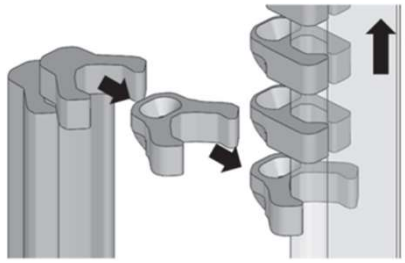

Melting


Casting
Primary wire

Melting & Casting


Y-shaped
profiled wire

Cold rolling


Using original machine

Shearing & Forging

Copper alloy for Metal Zipper

	CDA Number	Alloy Name
Cu-Zn	C23000	Red Brass
	C27000	Yellow Brass
Cu-Zn-Ni	C75400	Nikel Silver

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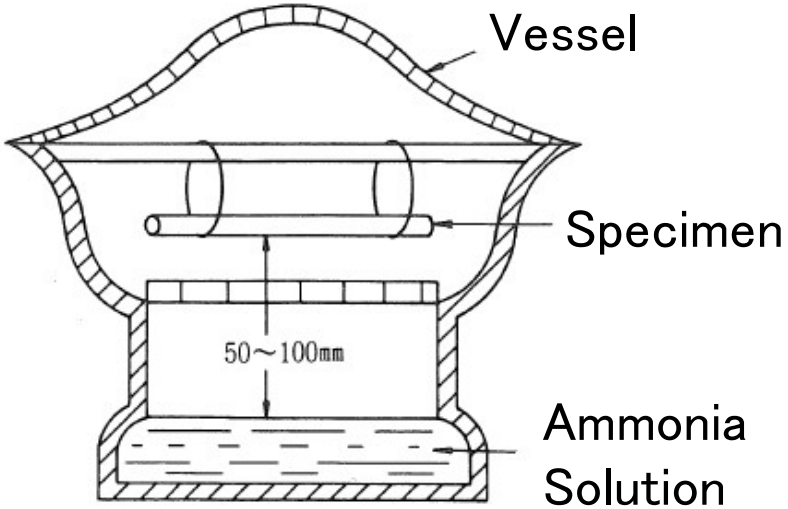
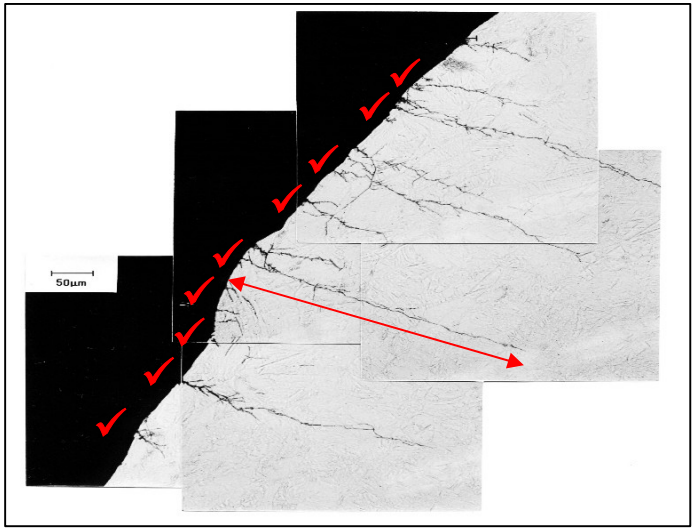
Muntz Metal (Cu-40wt%Zn)

	CDA Number	Alloy Name	Comp.(wt%)		Microstructure	SCC Sensitivity
			Cu	Zn		
Cu-Zn	C23000	Red Brass	85	15	α	Low
	C27000	Yellow Brass	65	35		
	C28000	Muntz Metal	60	40	$\alpha+\beta$	High

- Muntz Metal (Cu-40wt%Zn) is used as a good match to the color of Red Brass (Cu-15wt%Zn), because of its reddish color.
- The SCC sensitivity of Muntz Metal is higher than Red Brass and Yellow Brass.

General SCC Test





Expose the specimens to ammonia atmosphere

↓

Remove the specimens from the test vessel

↓

Observe the cracks by the stereomicroscope

Number of cracks (✓), Depth of cracks (⟷)

⇧

Qualitative Evaluation

General SCC test is often a qualitative evaluation.

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Objective

We introduce a quantitative SCC test method as an inspection, and the novel Cu-40wt%Zn alloy with low SCC susceptibility by microstructure control which we developed.

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2. Experimental Procedure

Pure Copper, Pure Zinc

↓

Melting & Casting
(Cu-15, 35, 40wt%Zn)

↓

Extruding (Φ20 Bar)

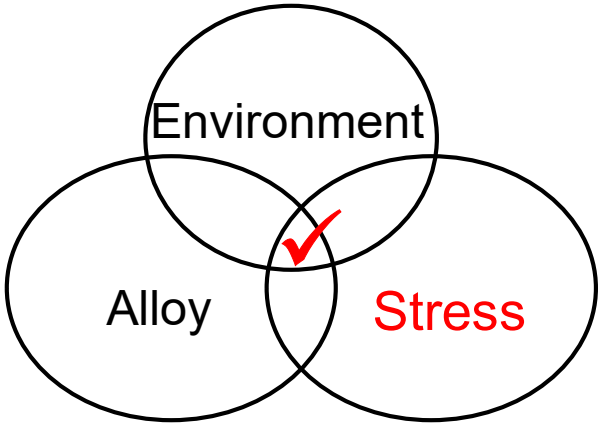
↓

Heat Treatment
(773～1023K ×21.6ks → Quench)

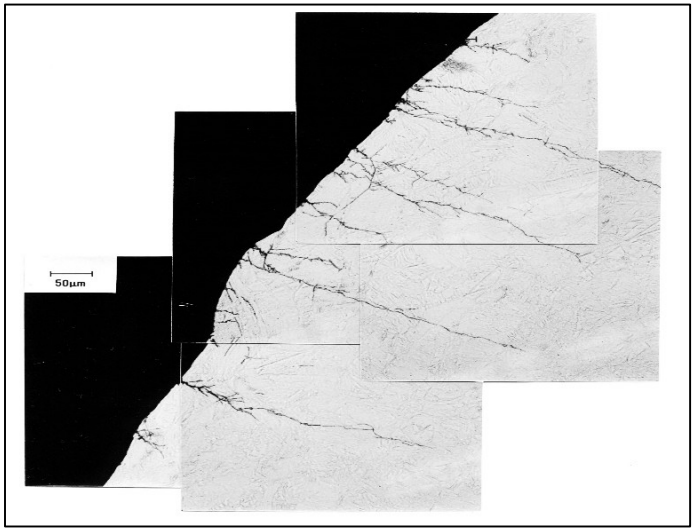
↓

Color Measurement	Microstructure Observation
Cold Rolling Test (Rolling Reduction : 20～80%)	SCC Test

(A) Residual Stress
(B) Loaded Stress



Three factors for SCC



SCC Test A

Residual stress by cold rolling

Expose the specimens to ammonia atmosphere

↓

Remove the specimens from the test vessel

↓

Observe the cracks by the stereomicroscope

Depth of cracks

SCC Test B

Loaded Stress by bending test
(100, 150, 200MPa)

Remove the surface Layer of the specimens

↓

Expose the stress-loaded specimens by bending test to ammonia atmosphere

↓

Remove the specimens from the test vessel

↓

Tensile test

Comparison of the tensile strength before and after exposure

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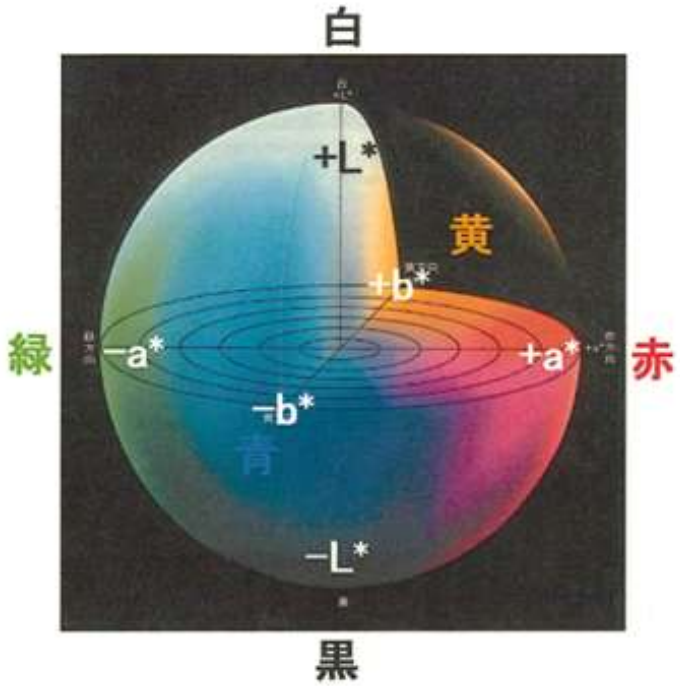
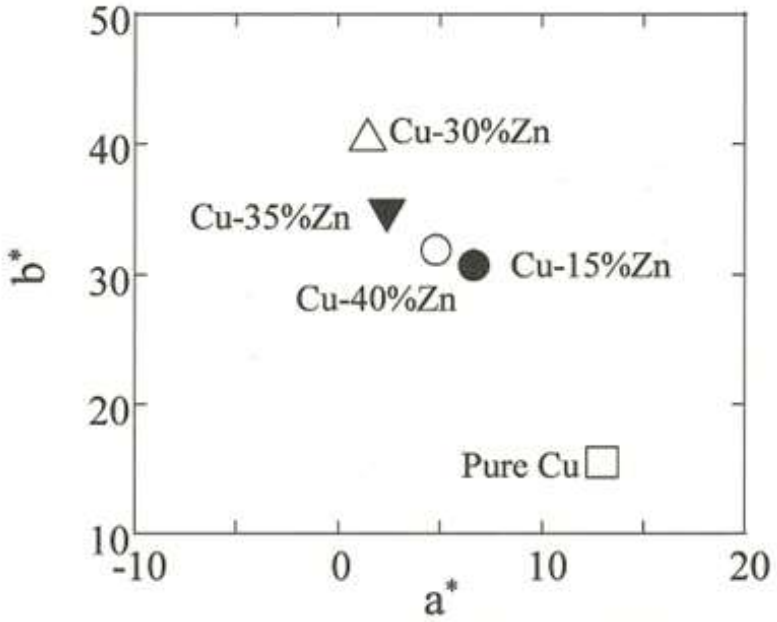
Color Measurement





Cu/Zn	L	a*	b*	⊿E
85/15	82.69	6.5	31.04	–
70/30	82.69	1.41	40.54	6.31
65/35	85.68	2.71	33.95	3.51
60/40	83.69	4.41	32.51	1.85

The color difference (ΔE) between Cu-40wt%Zn alloy and Cu-15wt%Zn alloy is about 1.9. The color of these copper alloys are nearly same.

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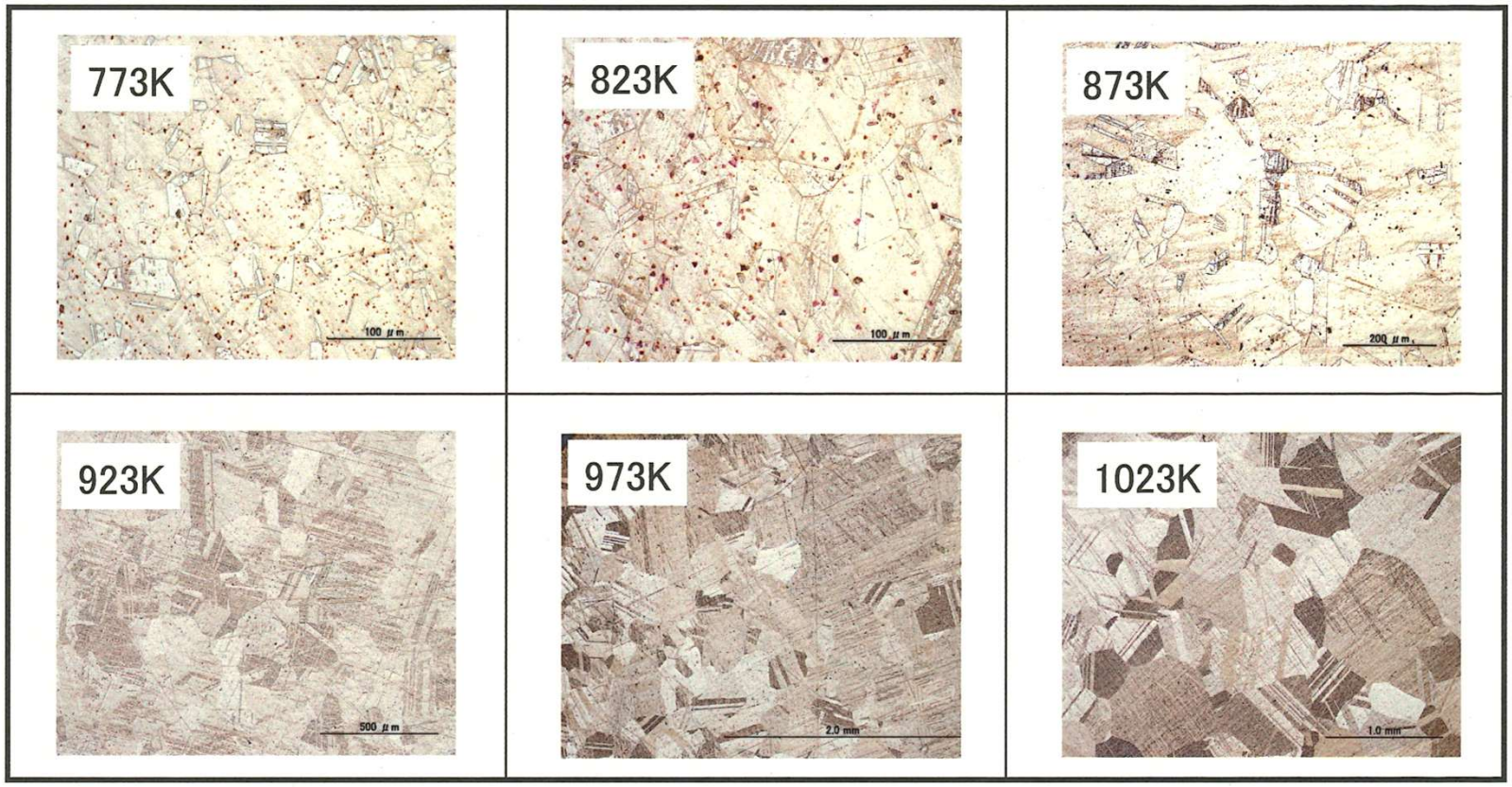
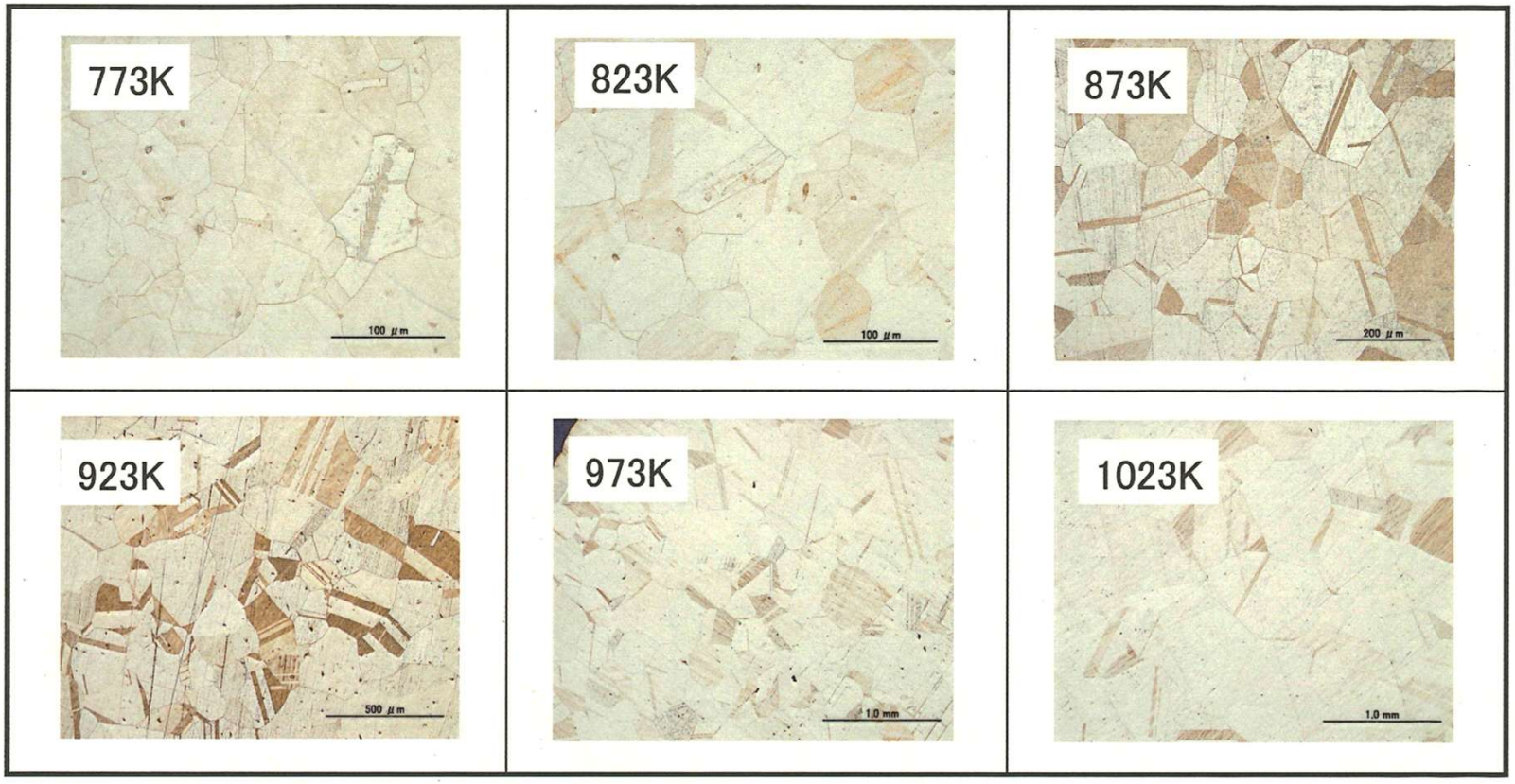
Microstructure Observation



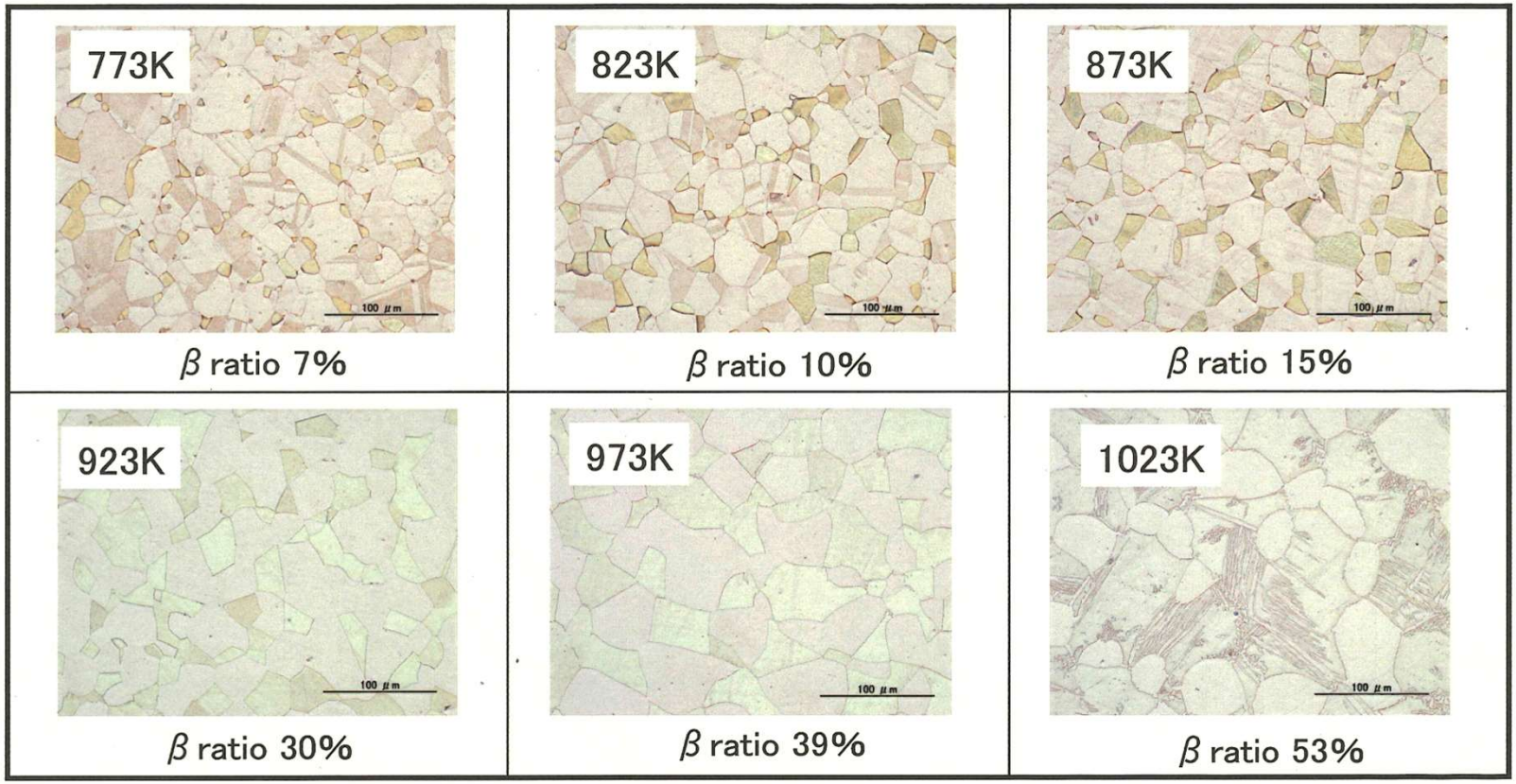
Cu-15wt%Zn

Microstructure Observation



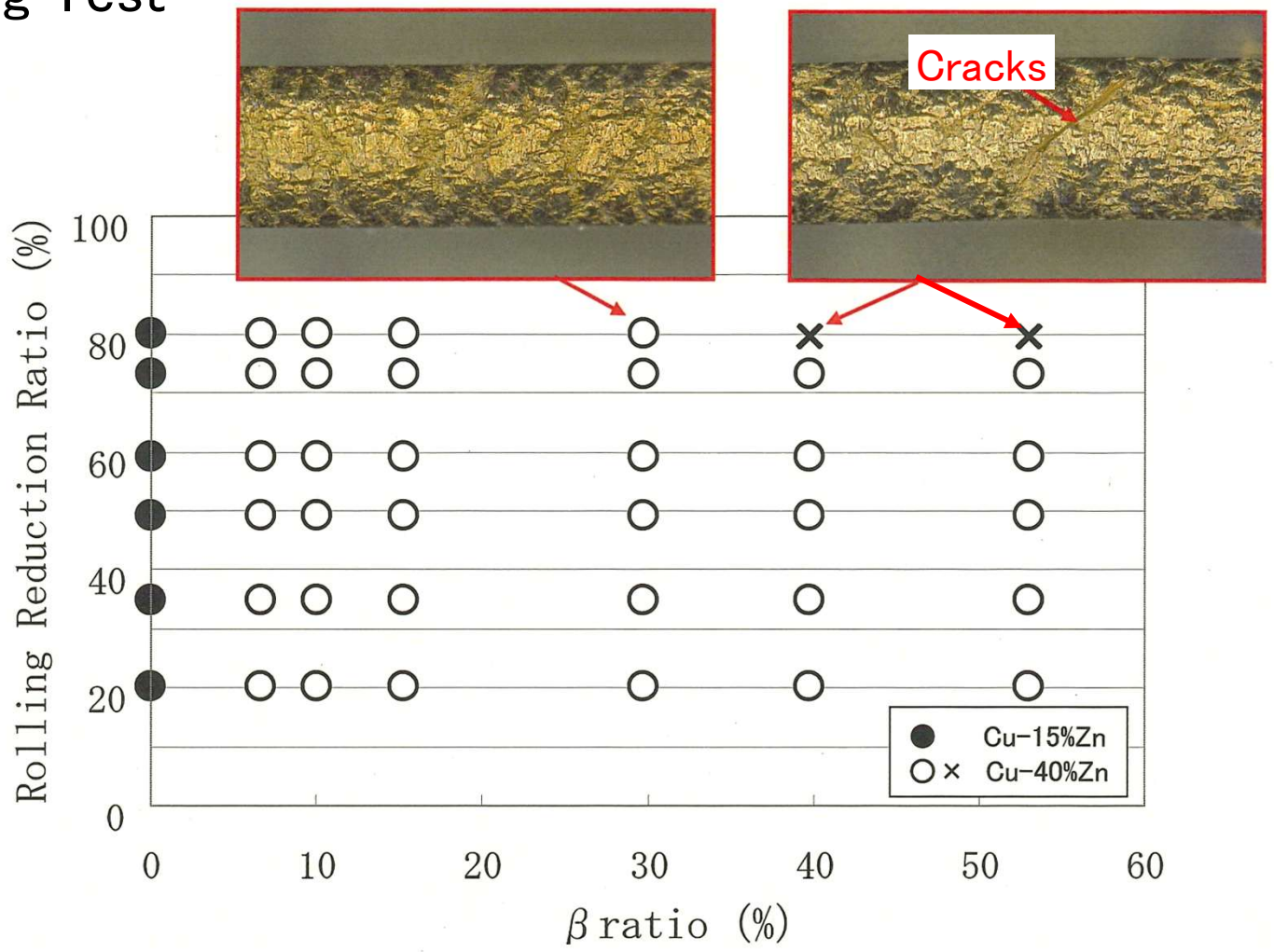
Cu-35wt%Zn

Microstructure Observation



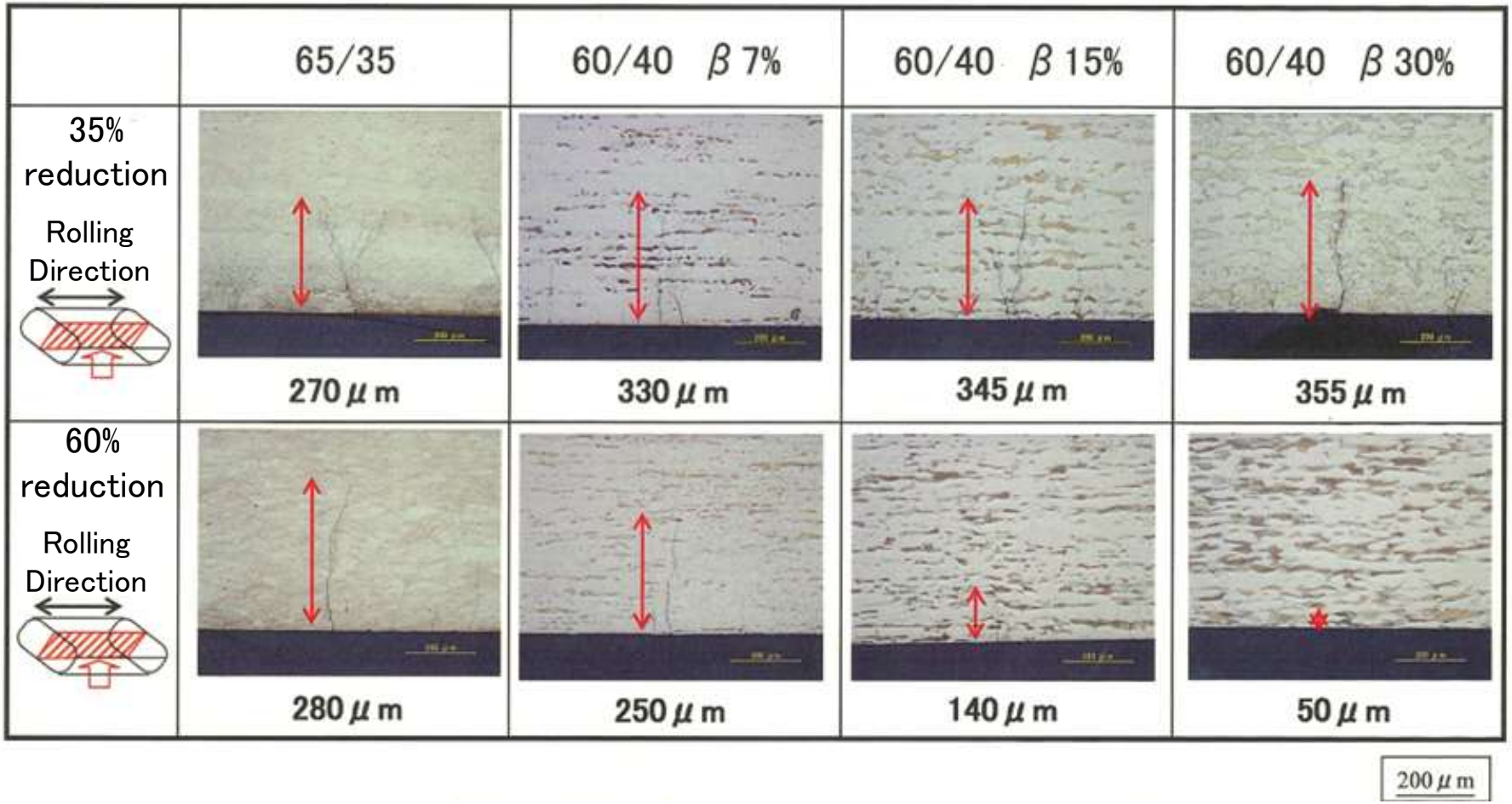
Cu–40wt%Zn

Cold Rolling Test



If the β ratio of Cu-40wt%Zn alloy is less than 40%, no crack and good cold workability at rolling reduction ratio up to 80%.

SCC Test A (Residual Stress)



SCC sensitivity of Cu-40wt%Zn alloy is improved by increasing β ratio and cold rolling reduction.

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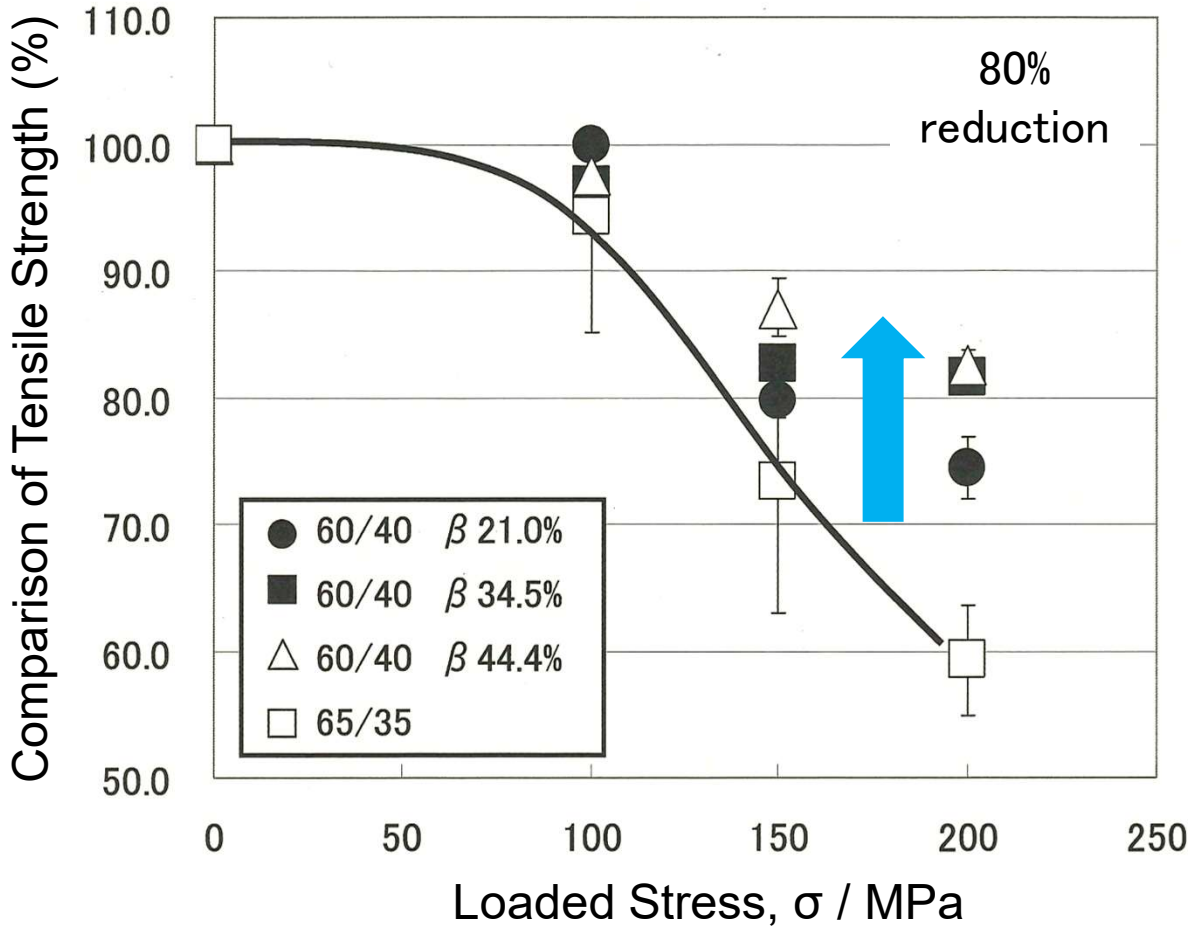
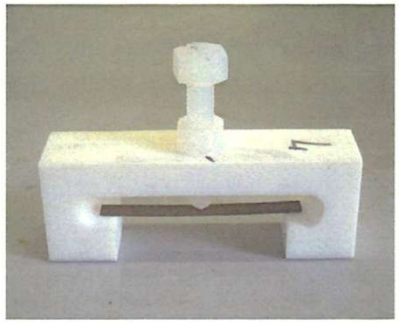
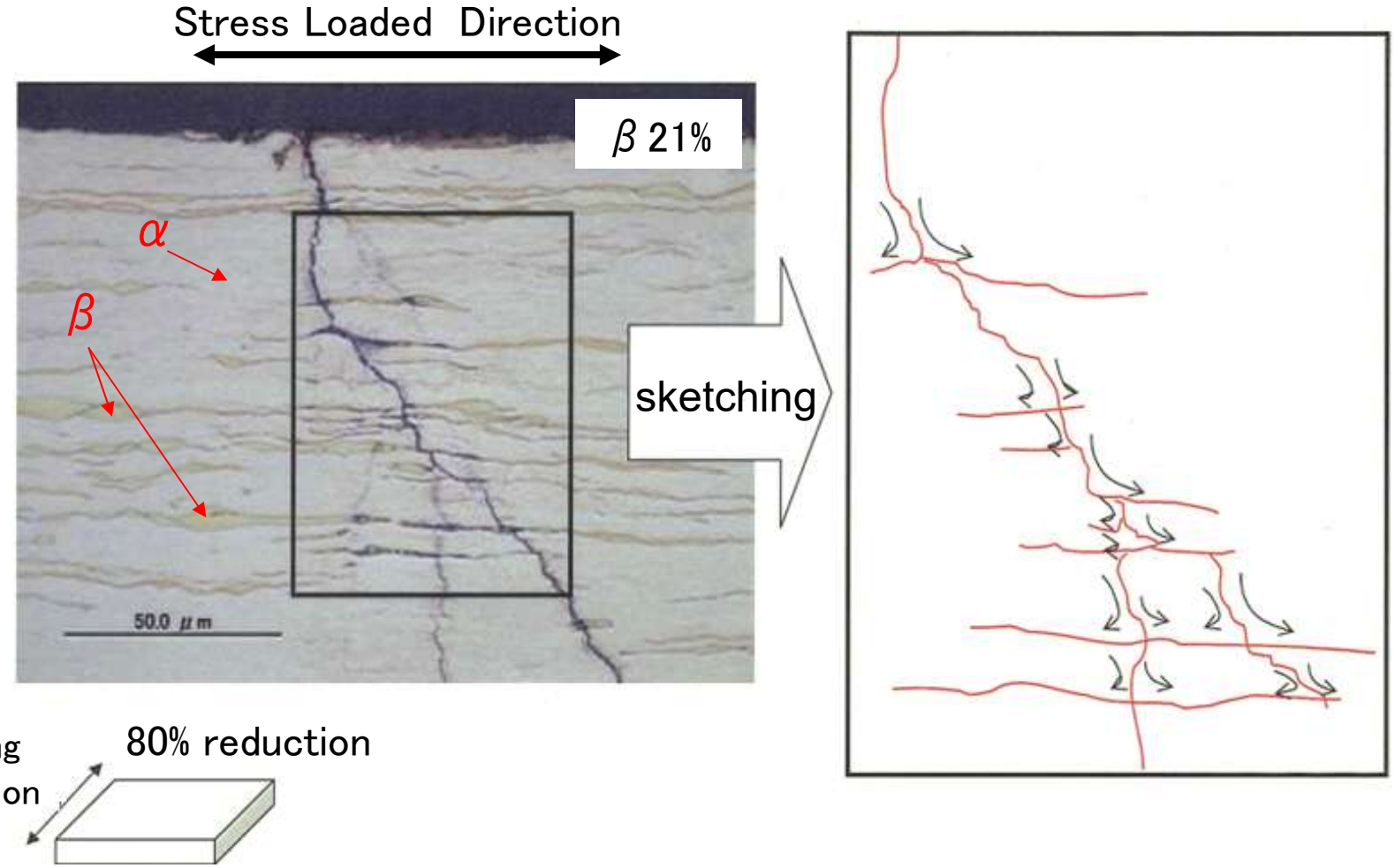
SCC Test B (Loaded Stress)





The SCC test method by bending test can show the quantitative SCC sensitivity of Cu–40wt%Zn.

SCC Test B (Loaded Stress)



The reason of the low SCC sensitivity of Cu–40wt%Zn is that the SCC cracks are branched and do not progress vertically by the fibrous β –phase.

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1) The color difference (ΔE) between Cu-40wt%Zn alloy and Cu-15wt%Zn alloy is about 1.9. The color of these copper alloys are nearly same.

2) If the β ratio of Cu-40wt%Zn alloy is less than 40%, no crack and good cold workability at rolling reduction ratio up to 80%.

3) SCC sensitivity of Cu-40wt%Zn alloy is improved by increasing β ratio and cold rolling reduction.

4) The SCC test method by bending test can show the quantitative SCC sensitivity of Cu-40wt%Zn.

5) The reason of the low SCC sensitivity of Cu-40wt%Zn is that the SCC cracks are branched and do not progress vertically by the fibrous β-phase.

THANK YOU

END OF SPEECH

Sustainability, speed, and quality,

to create a "Big Difference" into the future.

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