High Performance of High Density and High Transparency Indium Tin oxide (ITO) and Zinc Aluminum Oxide (ZAO)

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Outline

1) Material improvements: density and microstructure

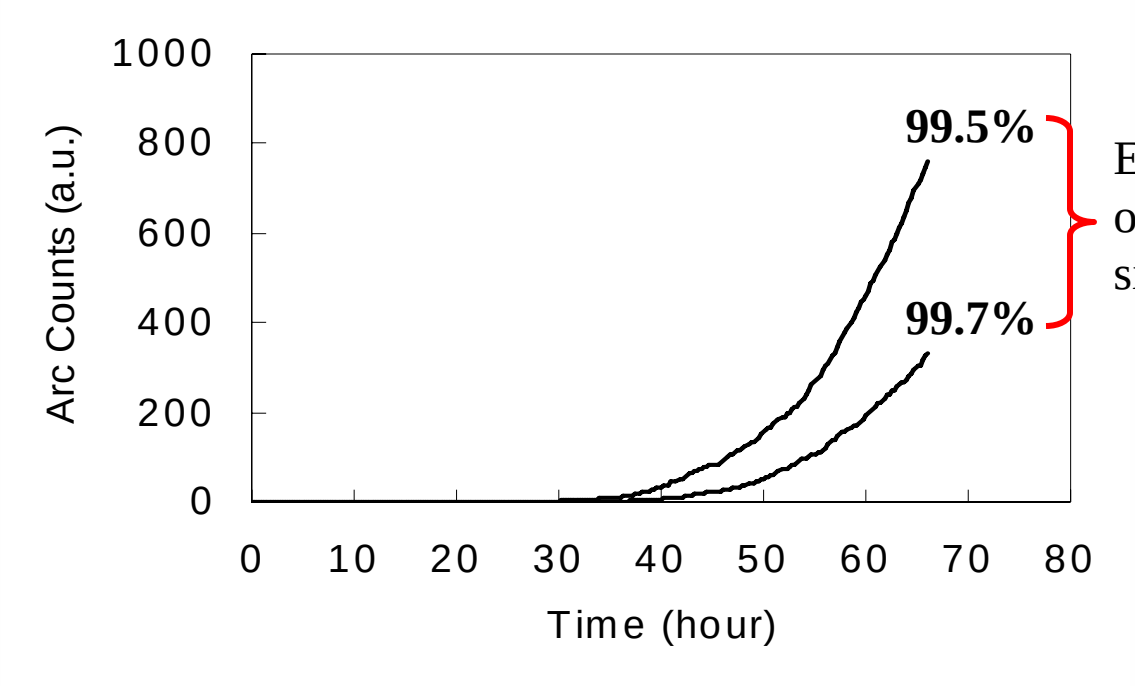
2) Bonding technique improvement

3) Transparency improvement

1) Material Density Improvements

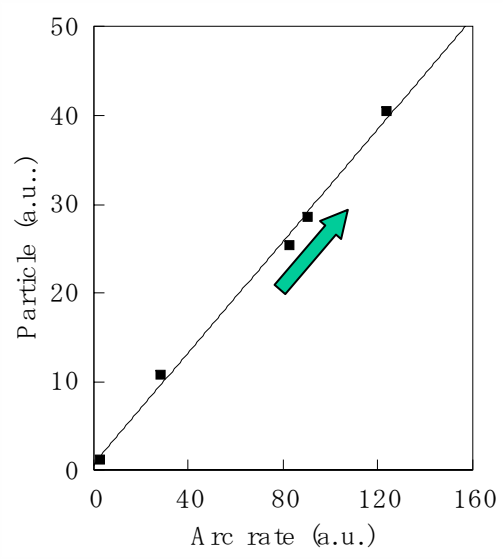
- Target density: > 99% of theoretical

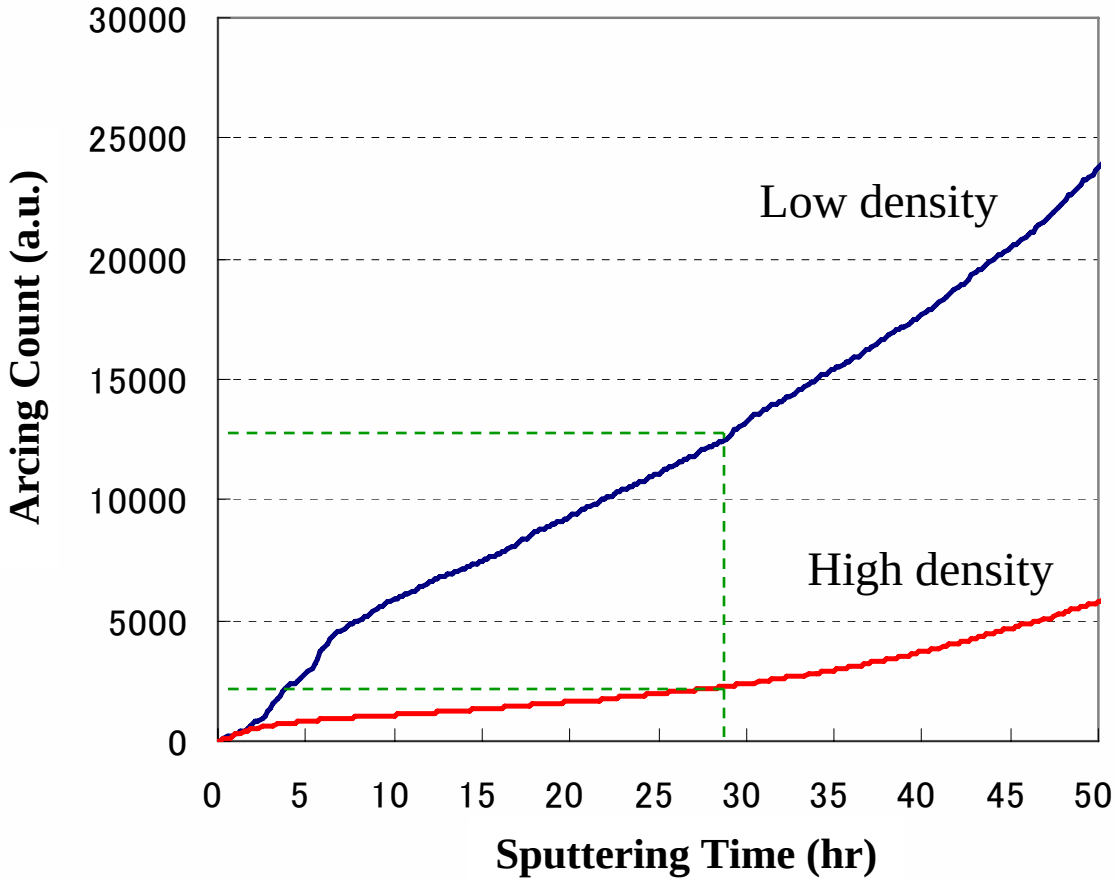
Higher density decreases the arcing events and particle emission during film deposition



Even small differences of density have a significant impact

1) Material Density Improvements





- Particle Emission increases with increasing arcing events

1) Material Density Improvements

• Example to quantify arcing events with respect to density over 28hr of sputtering

	Low density	High density
Arcing (Counts/hr)	**> 350**	**71**

*Data based on ZAO material

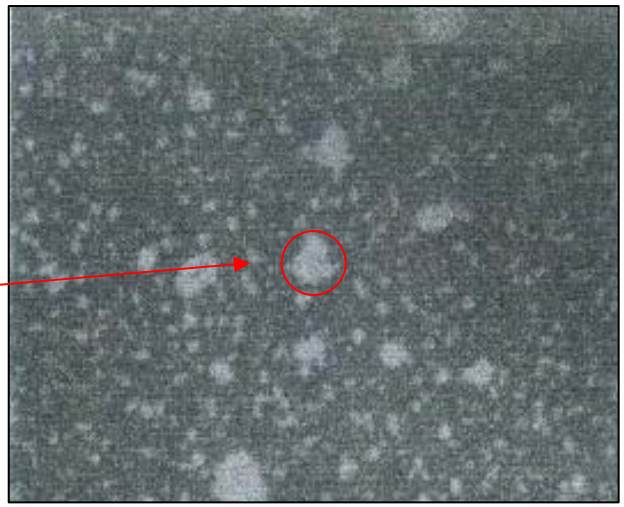
	High Performance
Arcing (Counts/hr)	**5**

1) Material Microstructure Improvements

• Microstructure uniformity (dopant distribution)

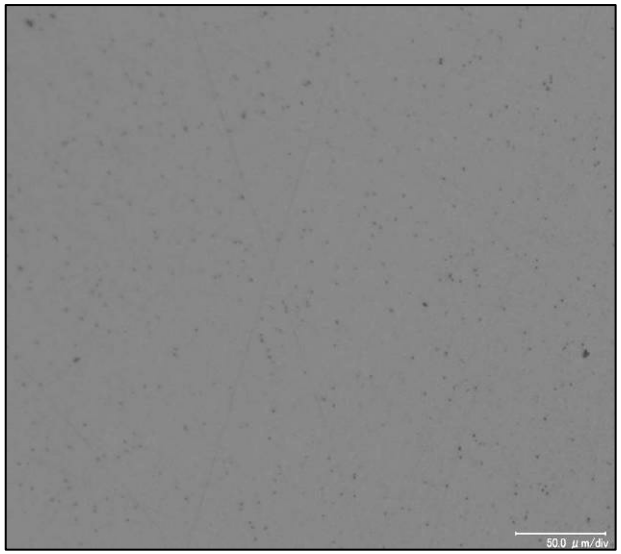
Non-uniform (ITO)

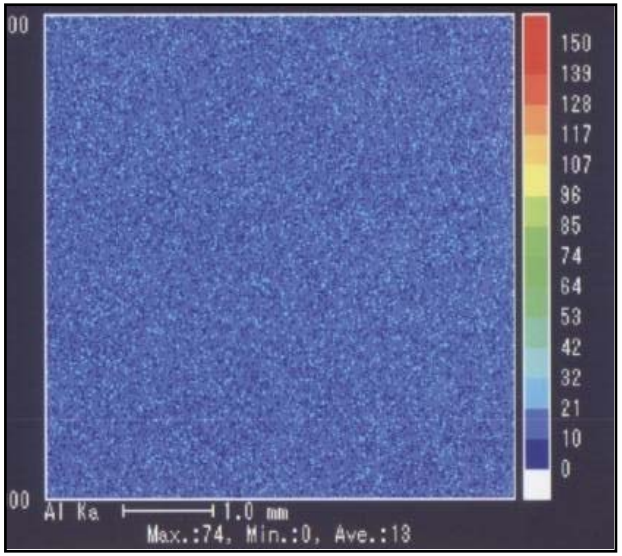
Sn



Uniform (ITO)

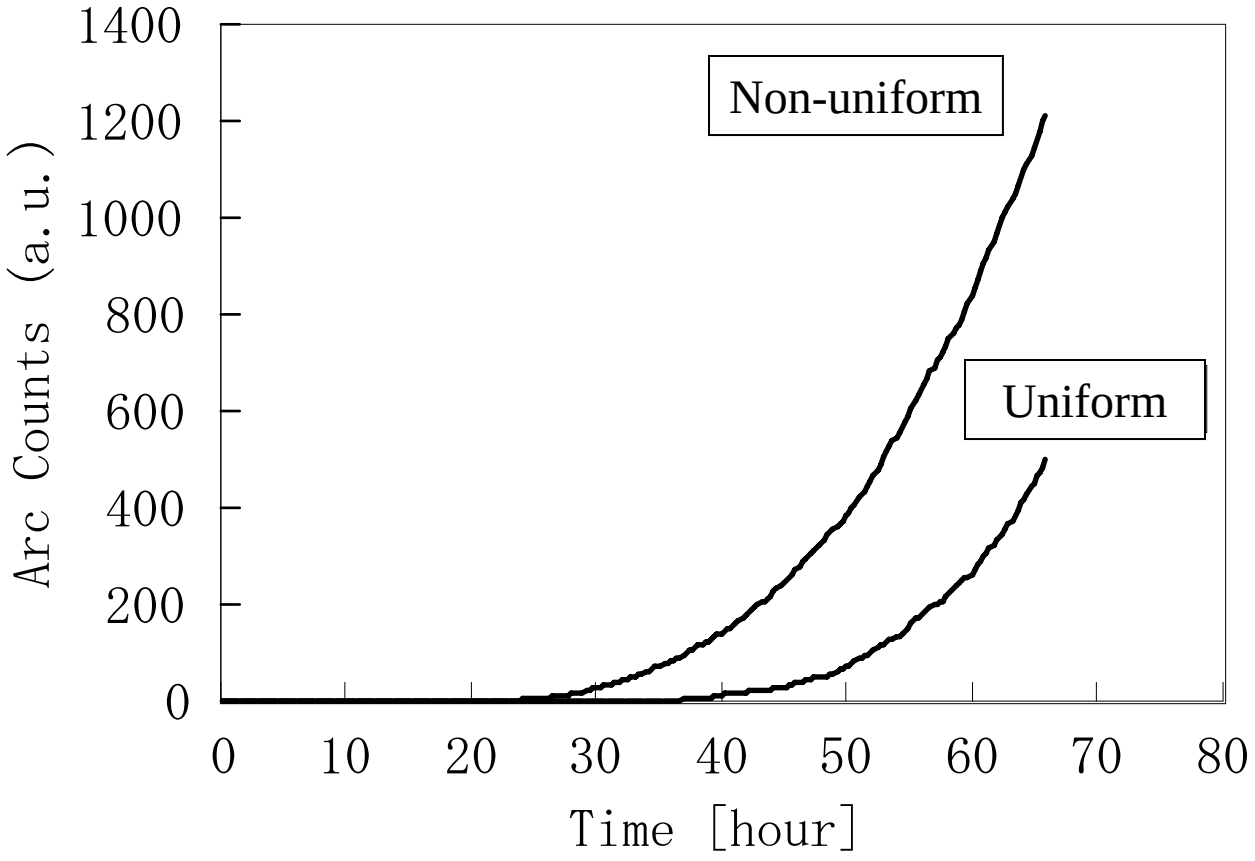
ZAO Microstructure





Aluminum Distribution

1) Material Microstructure Improvements



2) Bonding technique improvement

- Source material directly affects the performance of the deposited films.

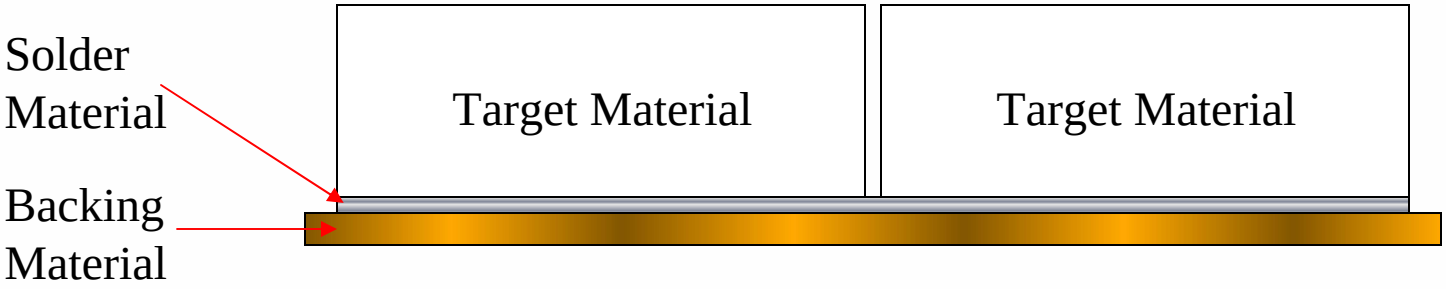
- Issues such as target cracking, contaminant substances reduce film performance.

    - Target cracking = bonding coverage.
    - Contamination = target assembly

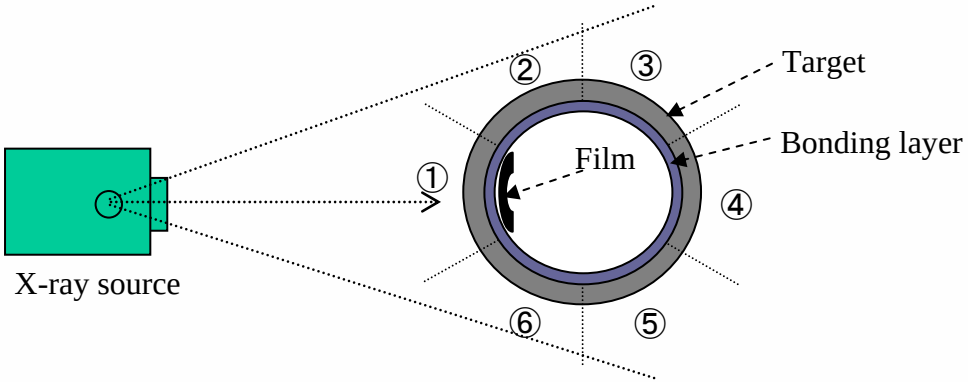
⇨ “Issues” translate into production output decrease

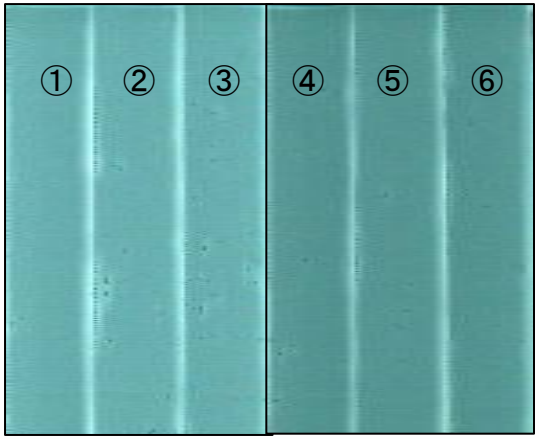
2) Bonding technique improvement

• Source material assembly



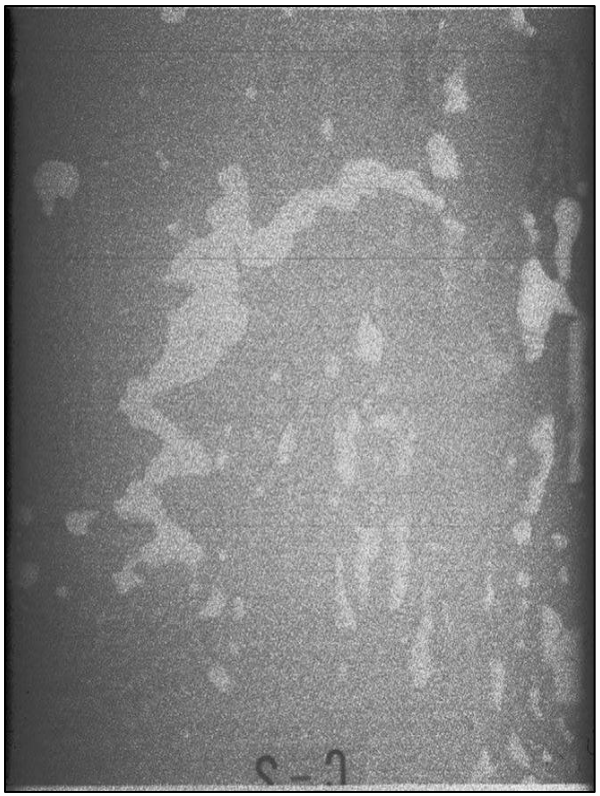
• X-ray Inspection system



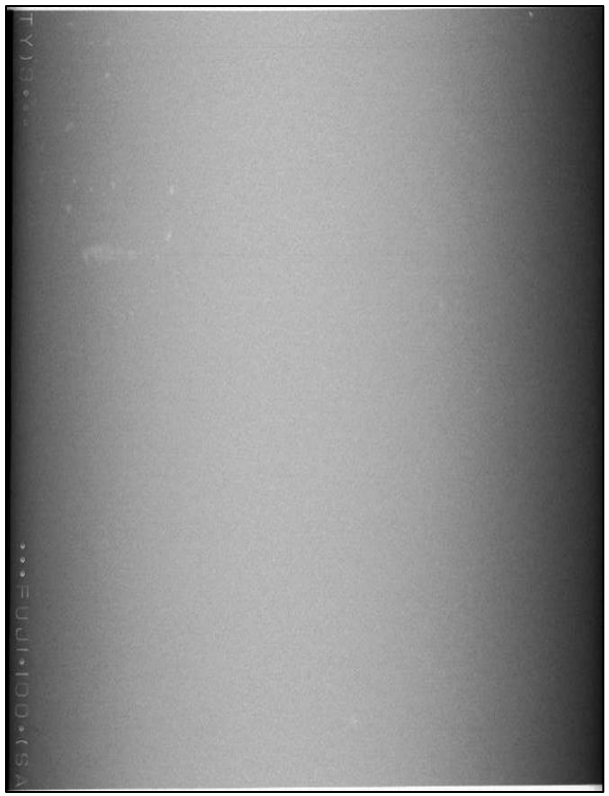


2) Bonding technique improvement

- Stability of source material during film deposition affects the performance of the film



Unstable (cracking is possible)



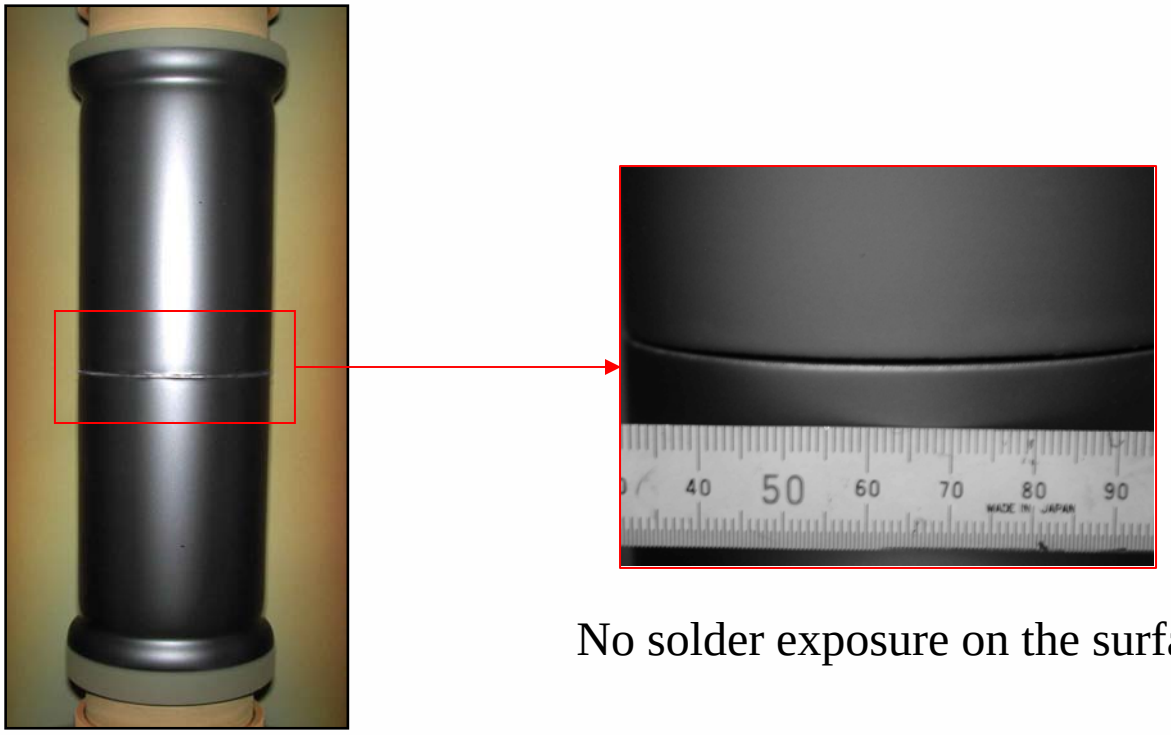
Stable

2) Bonding technique improvement

• Larger length sections reduces the number of gaps in the material

➡ Contamination reduction

➡ Arcing and Particle Emission reduction



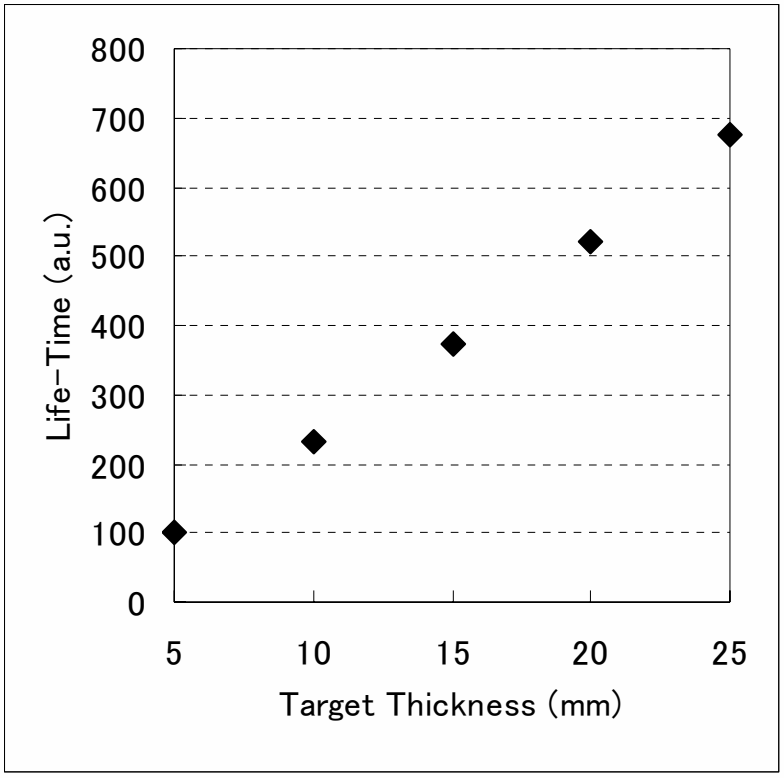
No solder exposure on the surface

2) Bonding technique improvement

- Material Thickness also favors high performance

➡ Mechanical stability : reduce cracking probability

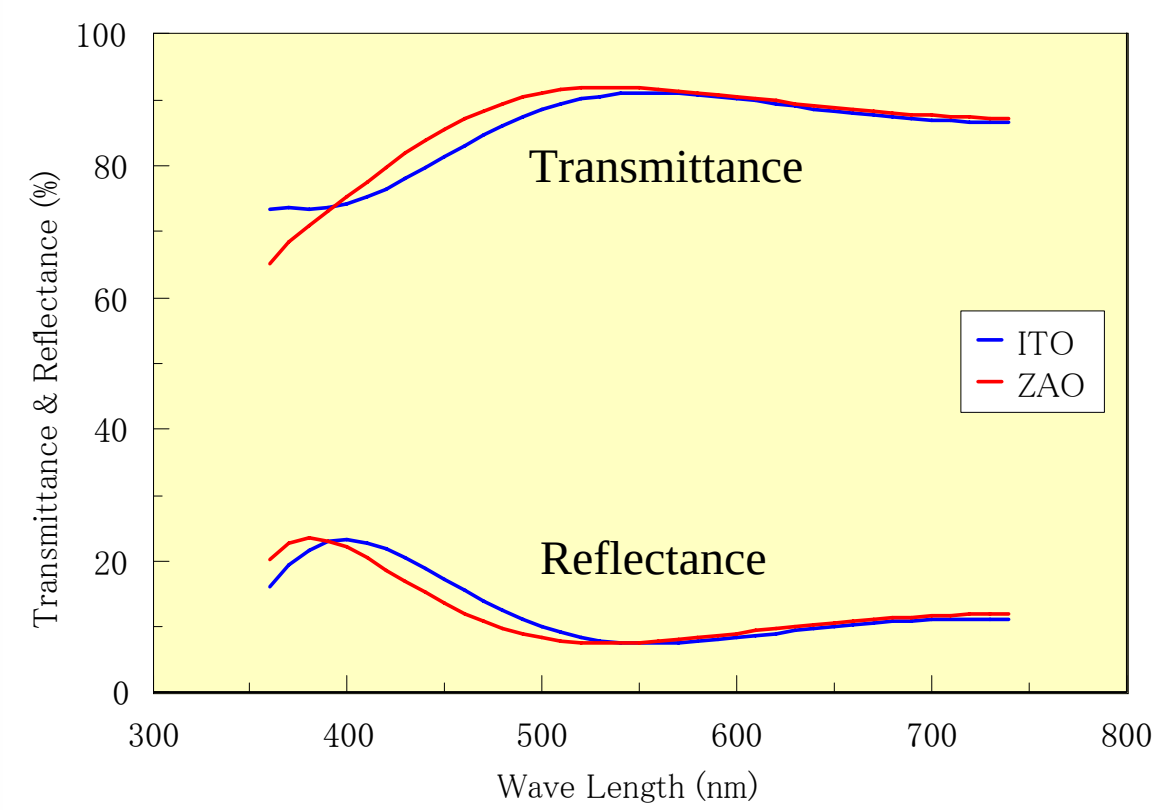
➡ Arcing and particle emission reduction



Final thickness:
8 mm
-No cracking
-No nodules

3) Transparency Improvements

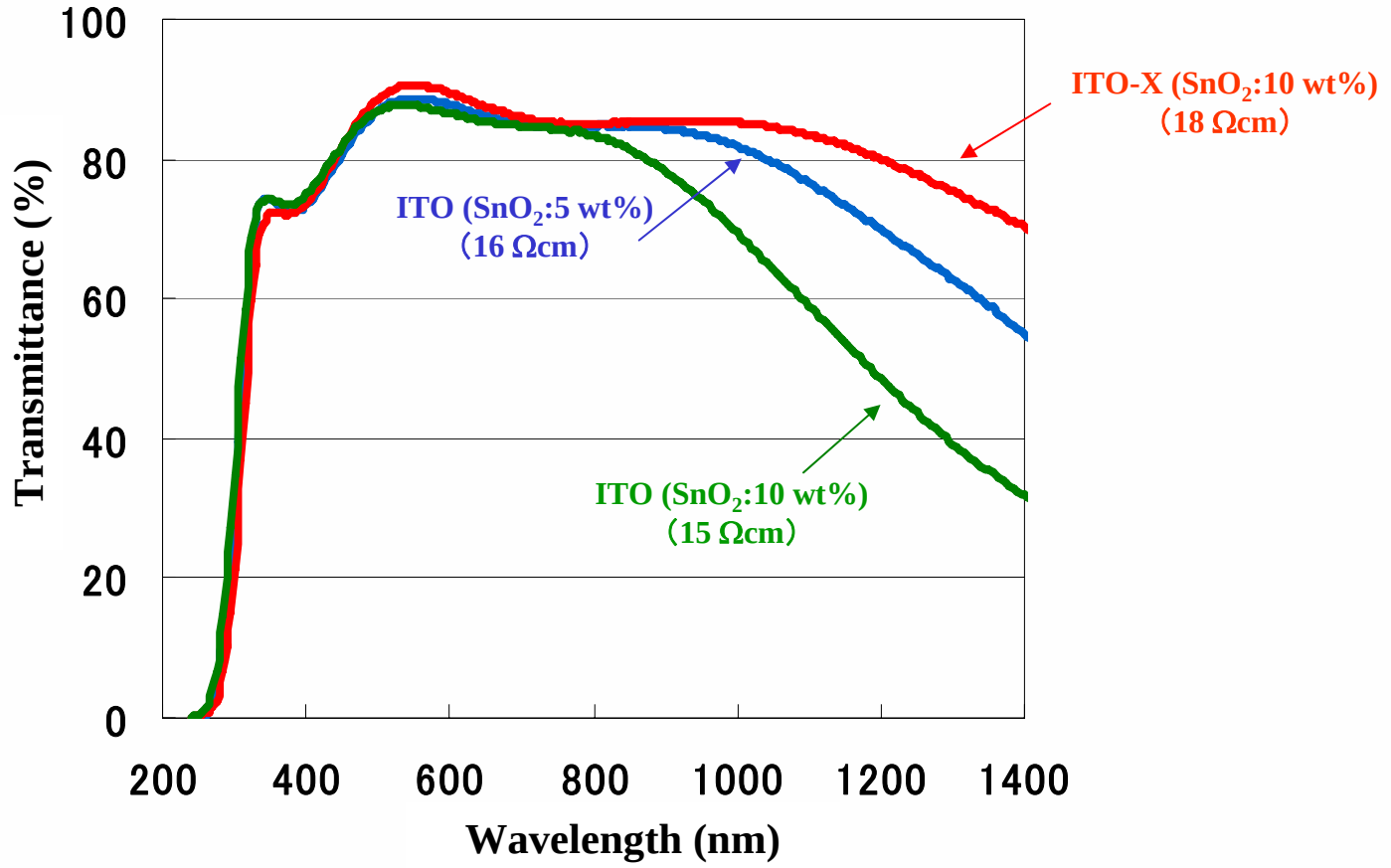
• “Standard” ITO and ZAO films transmittance



3) Transparency Improvements

- **Concept for new ITO film: ITO-X**

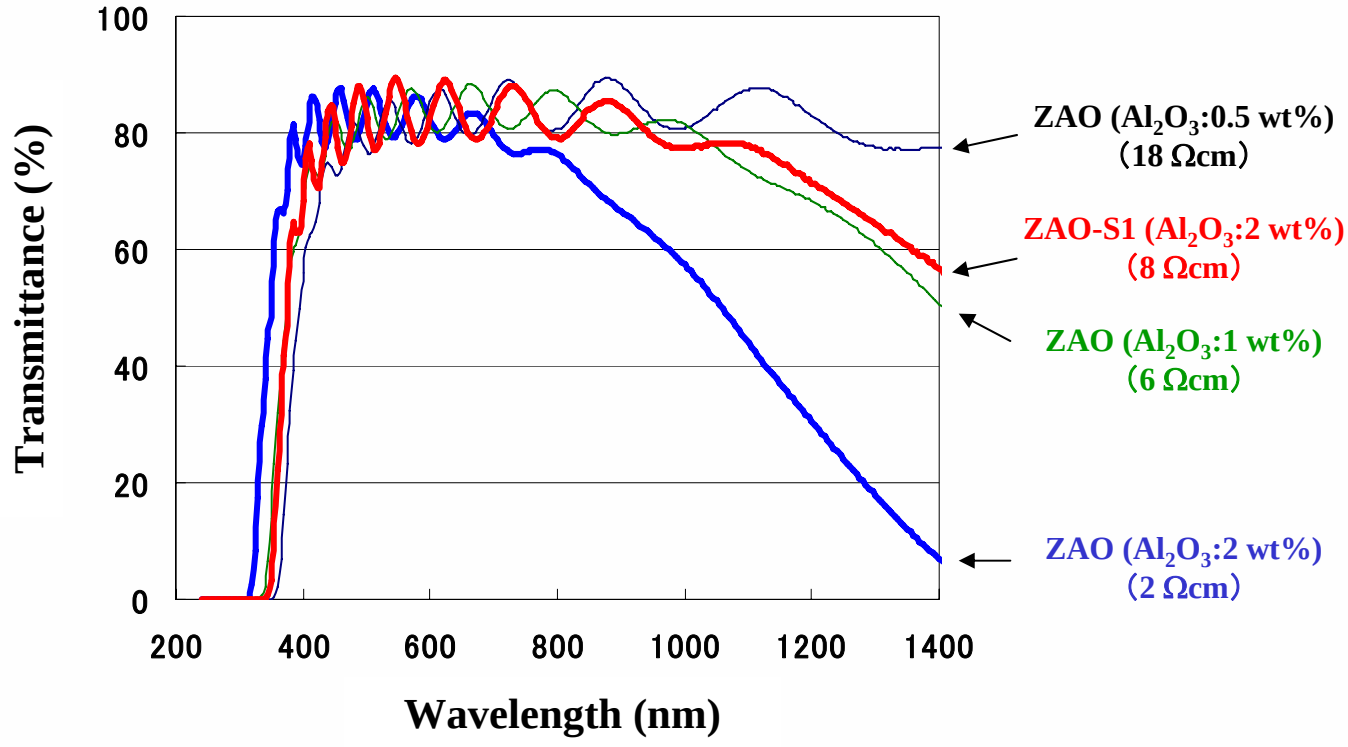
➡ Low film resistivity with higher transmittance at the infrared region



3) Transparency Improvements

- **Concept for new ZAO film: ZAO-S1**

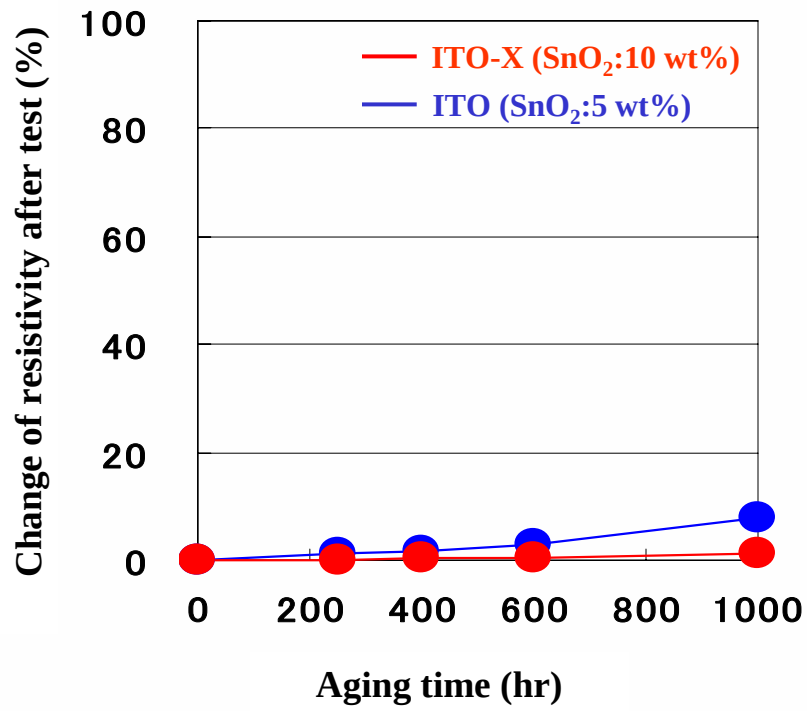
  ➡ Low film resistivity with higher transmittance at the infrared region



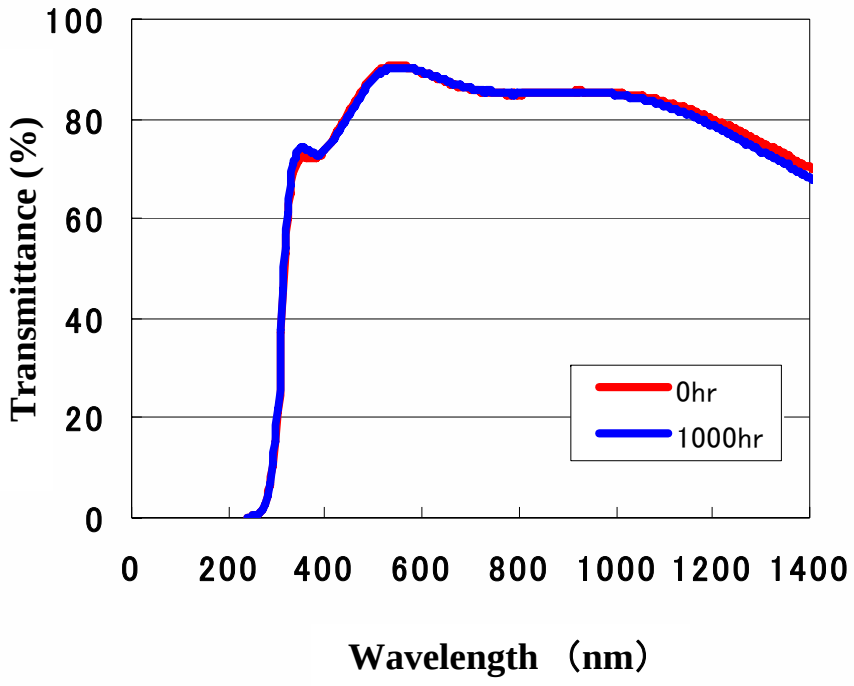
3) Transparency Improvements: ITO-X

- **Accelerated aging test: 85°C – 85% RH**

Resistivity Comparison



Transmittance Comparison

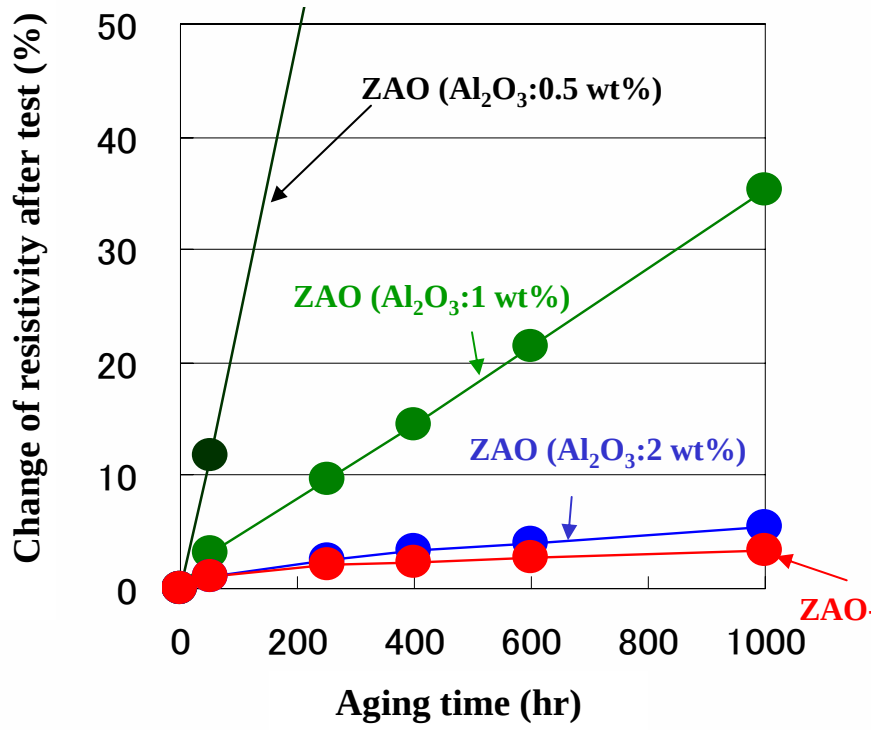


No change on resistivity over time
No change on transmittance

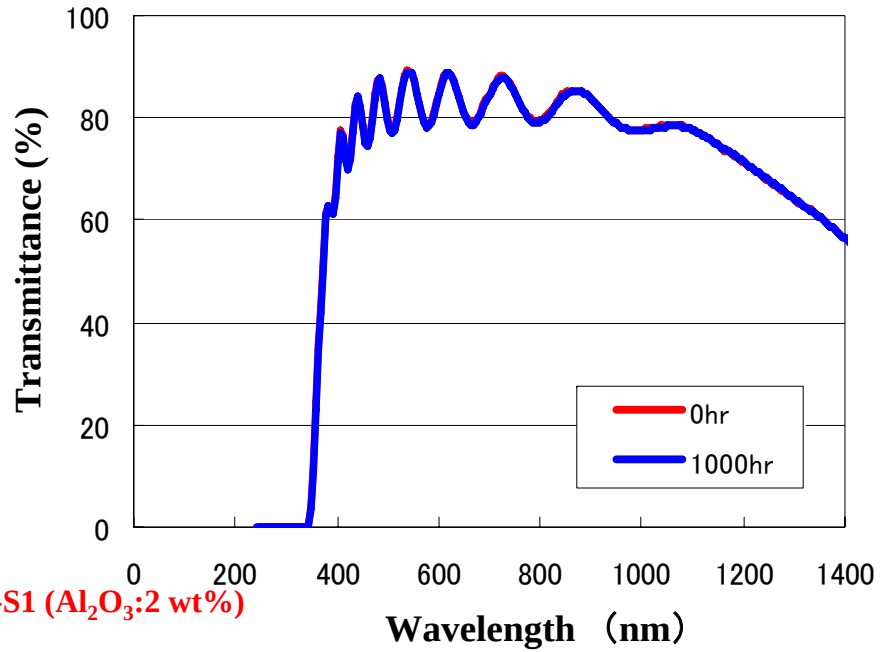
3) Transparency Improvements: ZAO-S1

- **Accelerated aging test: 85°C – 85% RH**

Resistivity Comparison



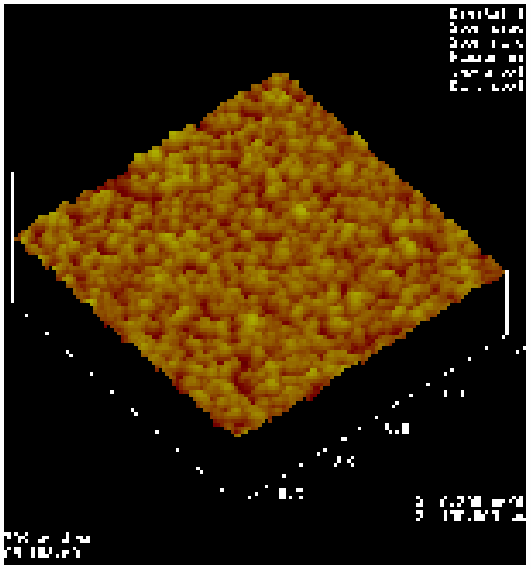
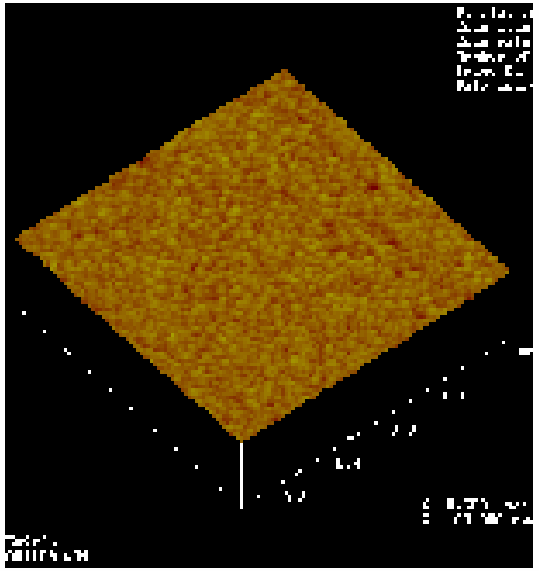
Transmittance Comparison



Improved resistivity over time
No change on transmittance

3) Transparency Improvements: Film Stability ZAO-S1

- **AFM Images/Heat Resistance**

	ZAO	ZAO-S1 (Improved)
		
Surface area（μm²）	**1.058**	**1.028**

Good humidity resistance → Small surface area

Summary

• Source TCO material quality and performance directly affects the performance of the TCO films

• High density material reduces arcing events and particle emission

• Microstructure uniformity improves the performance

• Target material stability reduces cracking and contamination during deposition

• High performance ITO-X and ZAO-S1 show improvement on film resistivity and film transmittance when compared with “standard” ITO and ZAO