

# JMON

Expert company for CIGS solar cells & AMOLEDs

# Distinctions of JMON

Extensive knowledge  
in Materials

We have provided our products based on our extensive experiences and understanding of materials.

Much experience  
In UHV

We have valuable and plentiful experience in UHV field.

Make a Difference

With our knowledge and know-how, we make differences and provide new technologies.

# Business Area

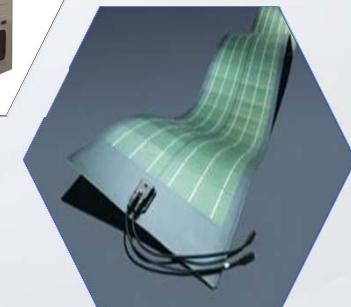
## CIGS solar cell

- Effusion cell : Cu, In, Ga, NaF, ...
- Cracker : Se, S
- Deposition system : Evaporator, Selenization, Sulfurization, Sputter, ...
- Post treatment system : RTP, Furnace, ...

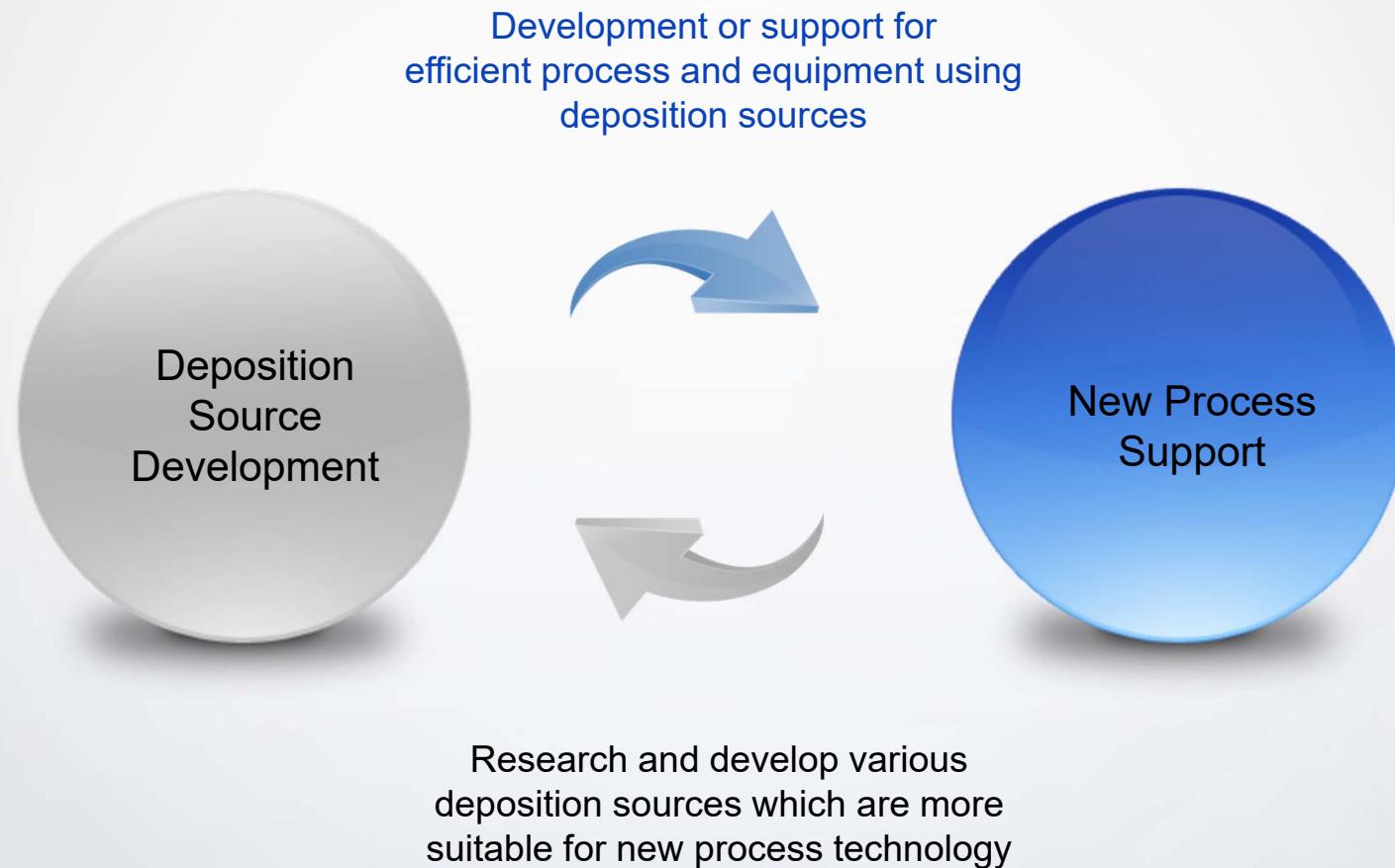


## AMOLED

- Effusion cell : Standard, Cold-lip, Multi channel, ...
- Deposition system : Evaporator, Sputter, ...
- Post treatment system : RTP, Furnace, Cabinet, ...



# Business Strategy



# Technical Reserves I (Effusion cell)

## \* Development plan for the effusion cells

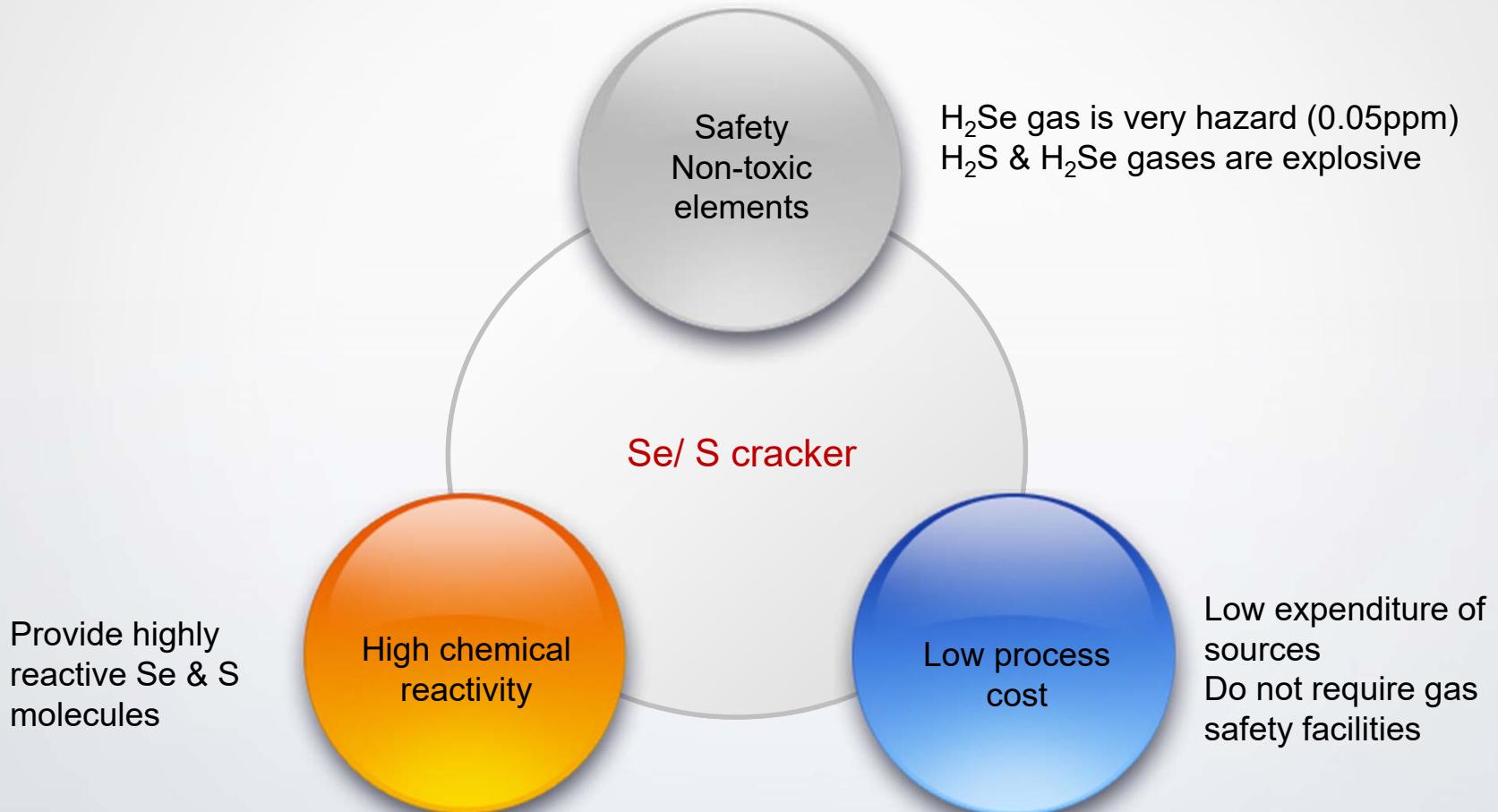
- Precision temperature control(<  $\pm 0.05^\circ\text{C}$  @  $1,000^\circ\text{C}$ )
- Atomic layer thickness control
- High purity thin film coating
- Parallel operation : composition control of several materials
- Use high capacity crucible for continuous process

## \* Application area

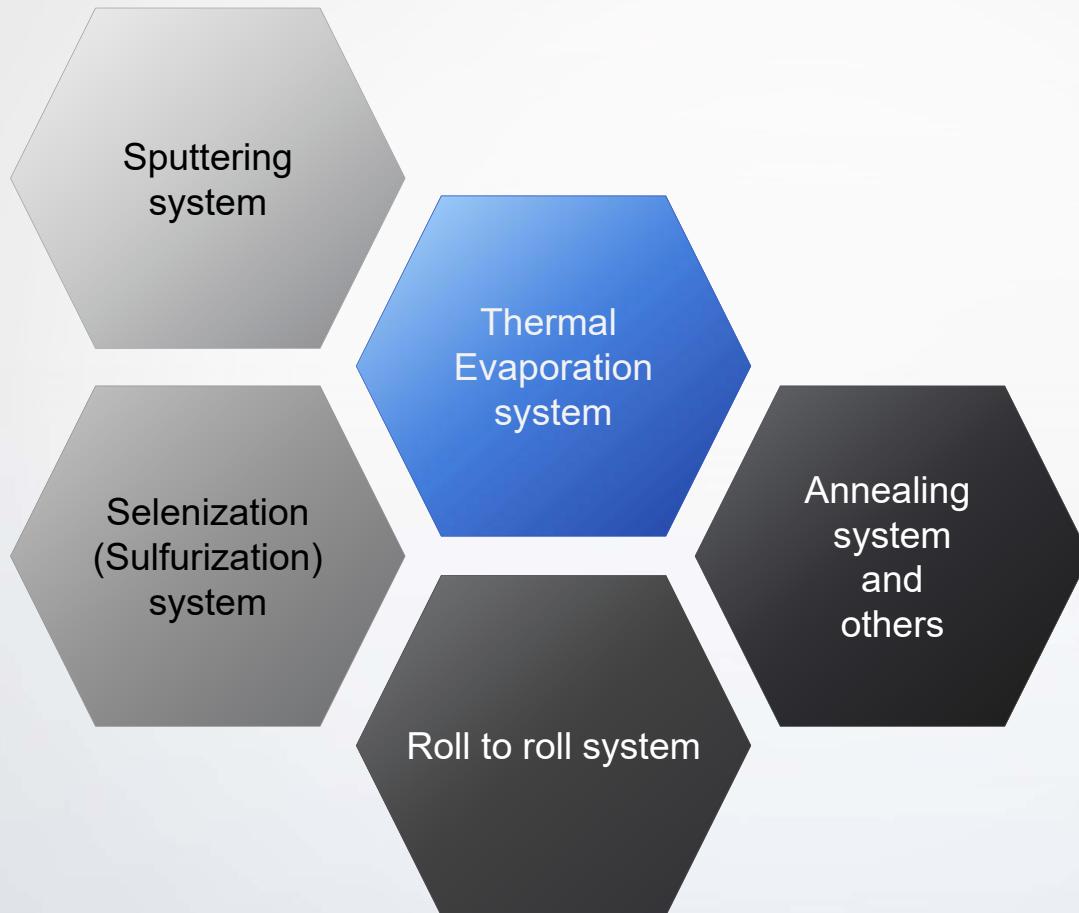
- LED(LD) production using vacuum deposition
- CIGS(CZTS) thin film solar cell : Cu, In, Ga, Se(S), Zn, Sn, ...
- AMOLED : Organics, Ag, LiF, ...
- Normal thin film coating(continuous process)
- Functional coating of mobile device : AFC ...



# Technical Reserves II (S/Se cracker)



# Technical Reserves III (PVD systems)



\* PVD= Physical Vapor Deposition

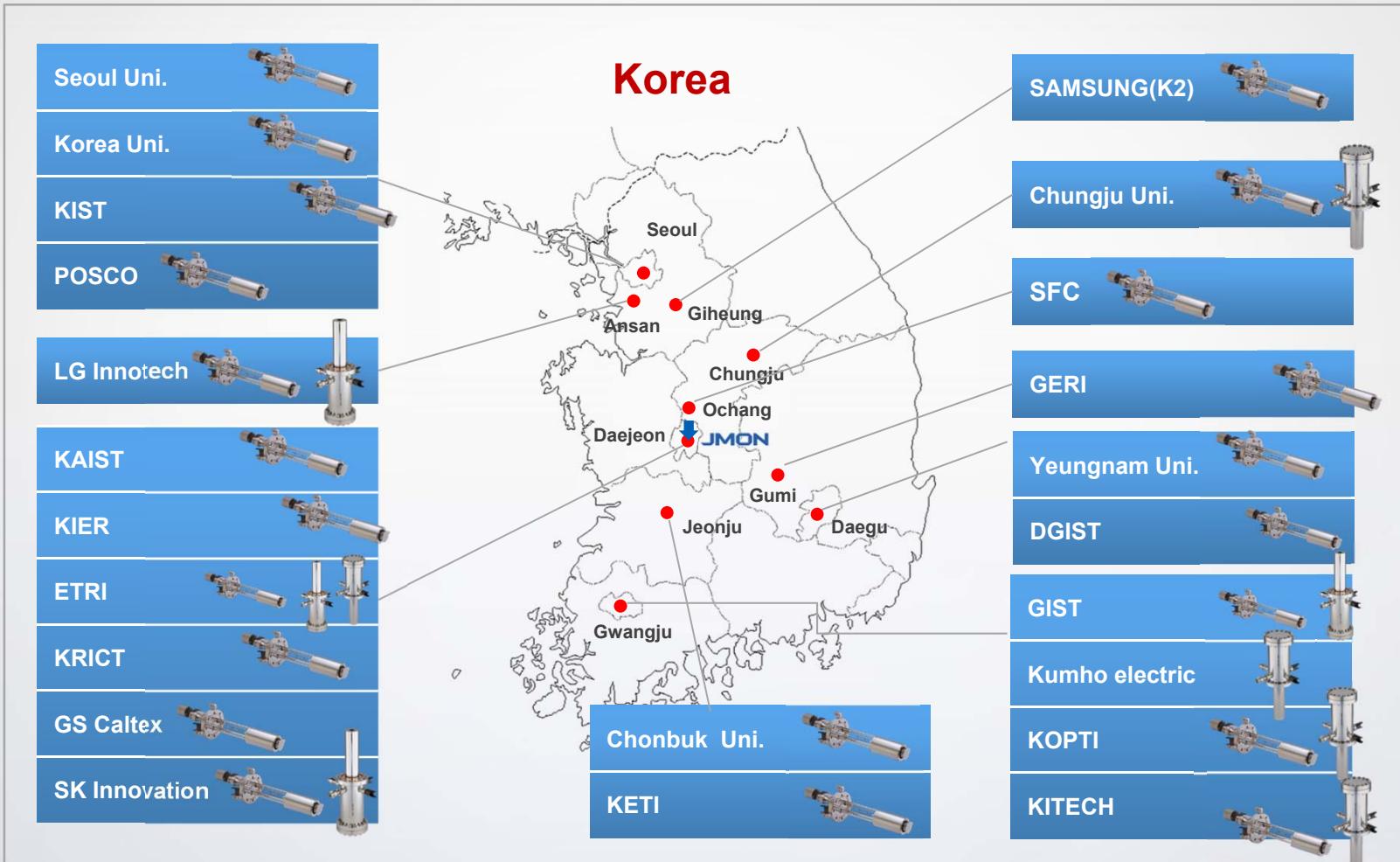
# Patent List

Patent number	Title of the invention	Date
10-0848709	Downward type deposition source	2008.07.21
10-0881434	Downward type linear deposition source	2009.01.23
10-0987993	Carbon nano tube film having excellent conductivity and optical transparency, and electronic devices and optical transmission type electrode obtained by using thereof	2010.10.08
10-1112597	Hybrid arc discharge methods for synthesizing of single wall carbon nanotubes	2012.01.30
10-1168706	Selenization process apparatus for glowing CIGS thin film on solar cell	2012.07.19
10-1214368	Downward selenium cracker	2012.12.14
10-1222879	Gas injection type cracker	2013.01.10
10-1839220	The cracker using plasma processing method	2018.03.09
10-1846692	Evaporation source with plate for preventing spitting	2018.04.02
10-1856327	Crucible-type effusion cell for metal film on substrate	2018.05.02

# Patent List

Patent number	Title of the invention	Date
10-2013-0098189	Crucible for Aluminum melting and the fabrication method thereof	2013.08.19
10-2017-0039798	Process apparatus for group 5 and 6 element reaction	2017.03.29
PCT/KR2017/006174	The cracker using plasma processing method	2017.06.14

# Supply List (CIGS/CZTS/OLED)



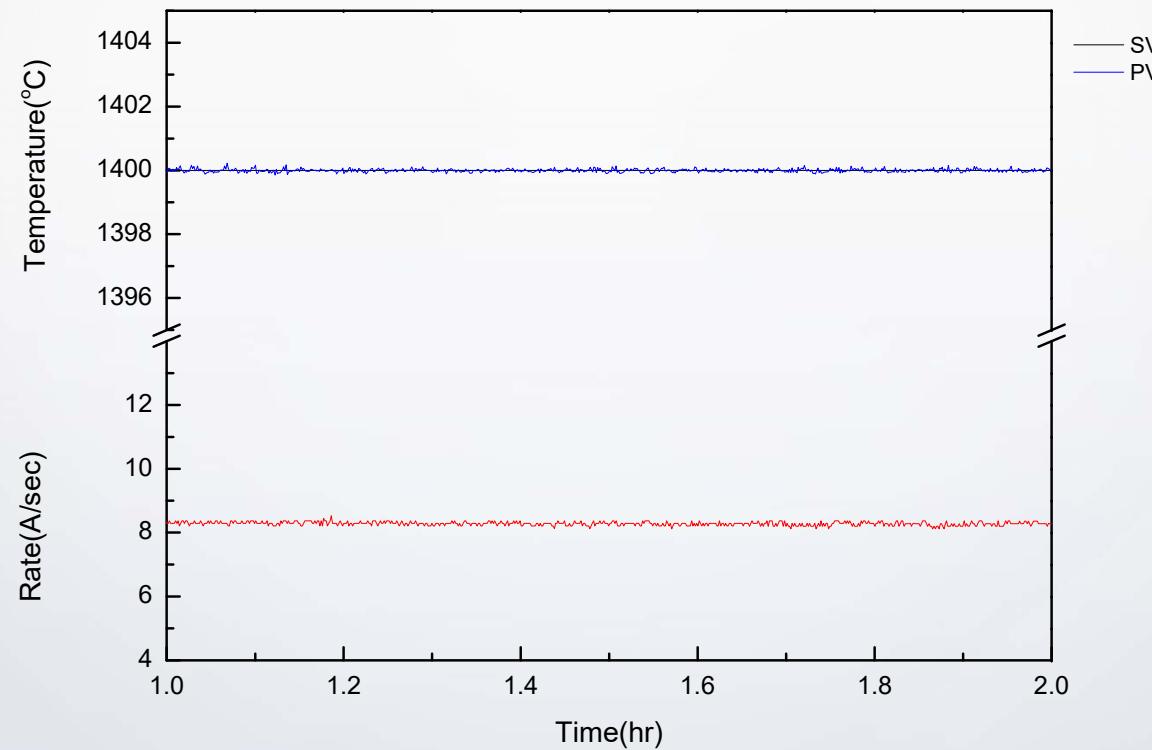
(  : Effusion cell,  : Cracker(Upward),  : Cracker(Downward))

# Performance of Effusion cells

Classify method	Designation	Operation temperature (°C)	Application materials
Operation temperature	Low-temp.	Up to 700 °C	High vapor pressure materials (Organics, Zn, As, Se, Mg, ...)
	Mid-temp.	700~1300 °C	Ag, In, Ga, LiF, Mn, Sn
	High-temp.	1300 °C and over	Low vapor pressure materials (Au, Cu, Ag, Si, Co, Ni, Fe, ...)
Construction or shape	Standard	Low ~ high temp.	(Normal materials)
	Cold-lip	Middle ~ high temp.	Crucible wall climbing material (Al)
	Hot-lip	Low ~ middle temp.	Sublimation materials (Organics, As, Se, LiF, ...)
	Dual-filament	Low ~ high temp.	Crucible wall climbing & spitting materials (Al, Ag, Cu, In, Ga, ...)
	Cracker	R(~400 °C), C(~1000 °C)	Poly-atomic molecule materials (Se, As, P, S, ...)
	Multi-channel	Low ~ high temp.	(Normal materials)

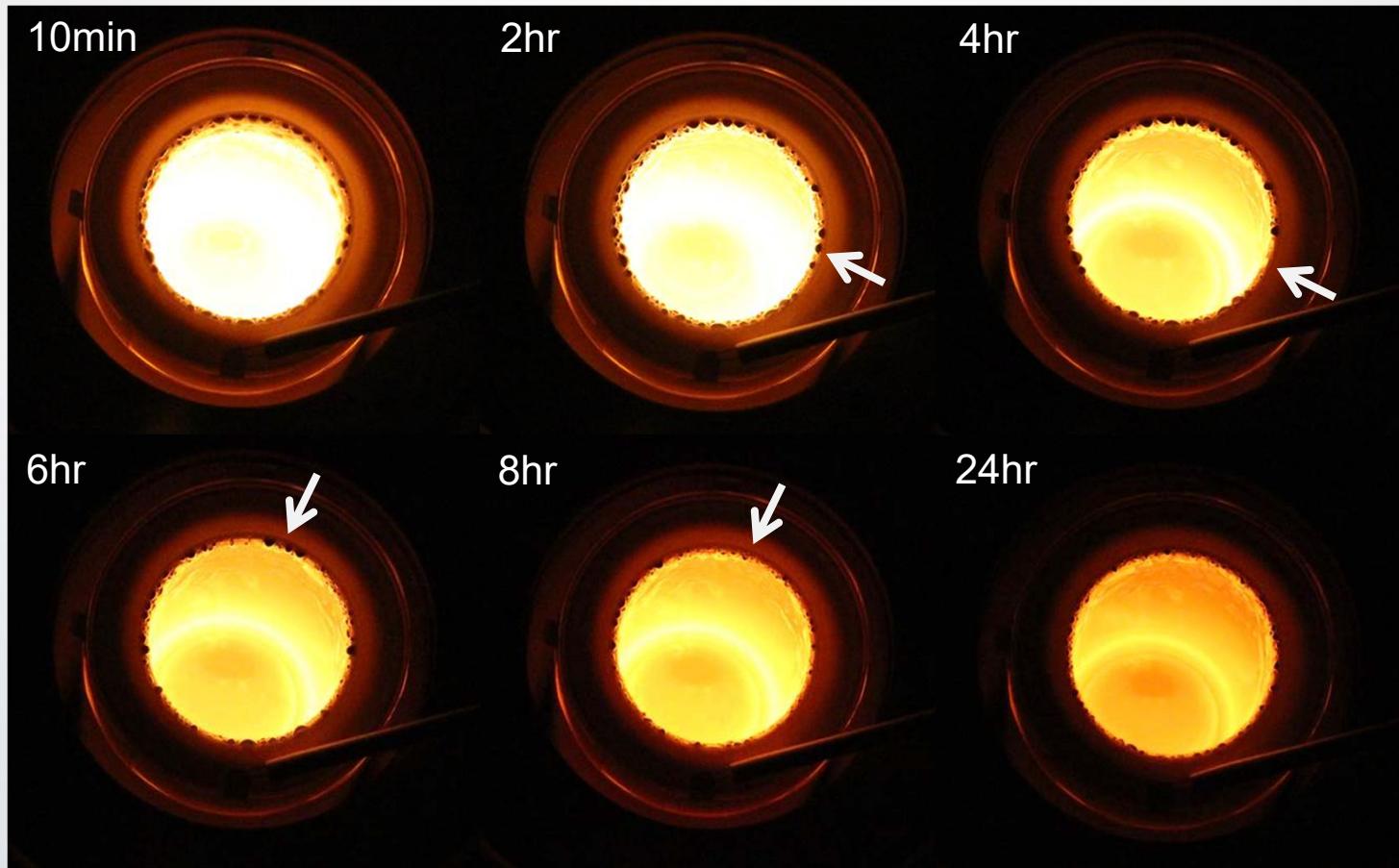
# Performance of Effusion cells

- The temperature stability and deposition rate change of aluminum at 1400 °C
  - Temperature deviation : <  $\pm 0.1$  °C (reliability : > 98.5%)
  - Rate deviation : <  $\pm 0.15$  Å/s (reliability : > 98.7%)



# Pictures of Al effusion cells

- The change of crucible lip during the 24hr deposition

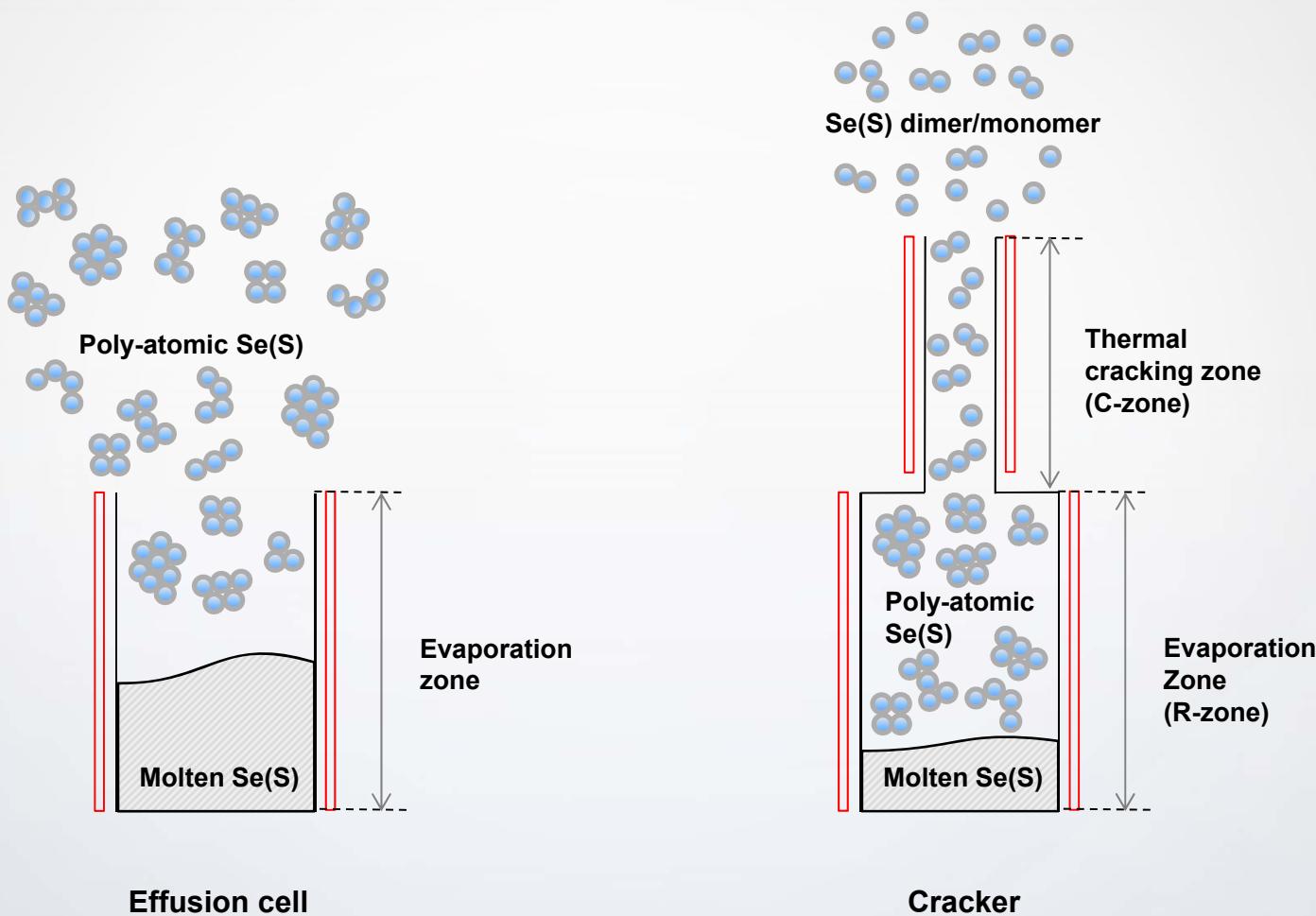


\* There is no overflow of aluminum during the test.

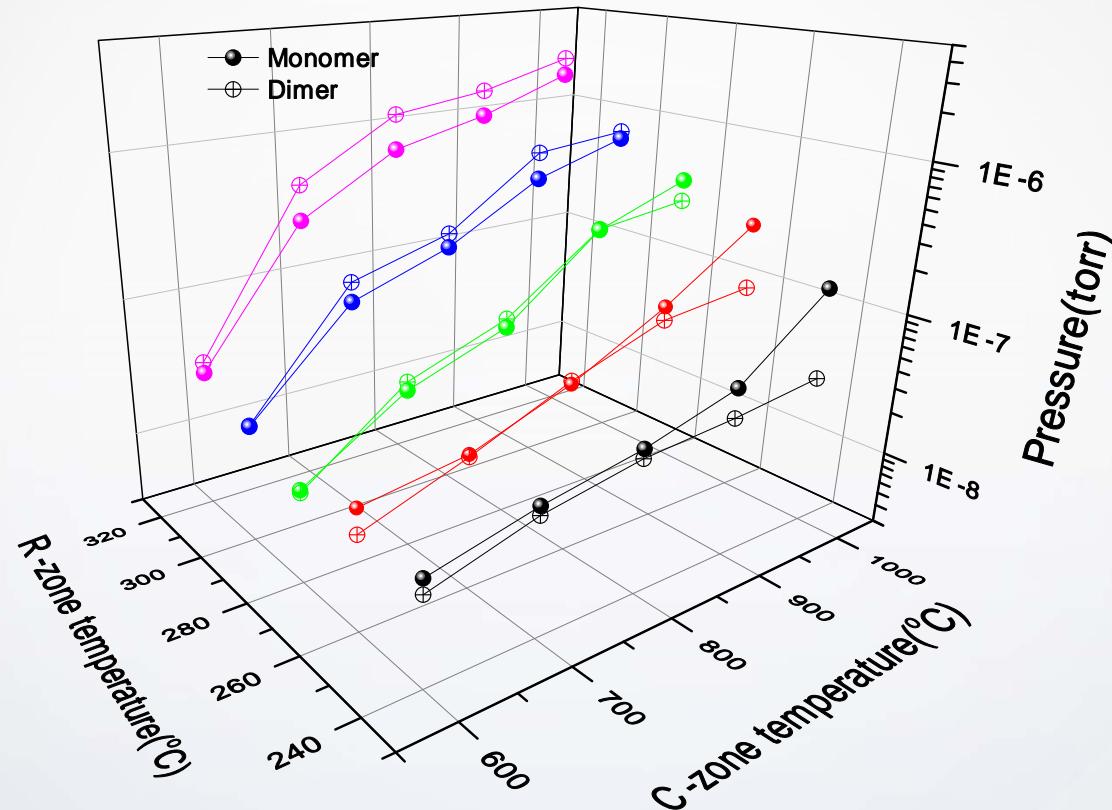
# Effusion cell for mass production(Ag, Al)

Model	SMS-1500CP-500AG	SMS-1500CP-500AL
Mounting type	Flange type(Socket type available on request)	
In-vacuum length		339mm
In-vacuum OD		86.5mm
Filament	Self supported W wire(Single zone)	
Heat shield		Ta sheet
Thermo-couple		Type C
Operation temperature (Power)		Max. 1500 °C (< 2kW)
Temperature deviation		± 0.05 °C (@1400 °C)
Application material	Ag	Al
Crucible capacity	PBN 500cc	AIN 430cc / PBN 500cc
Deposition rate (@TS 700mm)	Max. 13A/s	Max. 50A/s
Trouble issue	Clogging, Spitting	Wall climbing, Crucible fracture
Solutions	Nozzle, Insert plate( <b>patented</b> )	Cold-lip( <b>patented</b> ), New materials( <b>TiB<sub>2</sub>BN</b> ...)

# Concept (Effusion cell vs. Cracker)



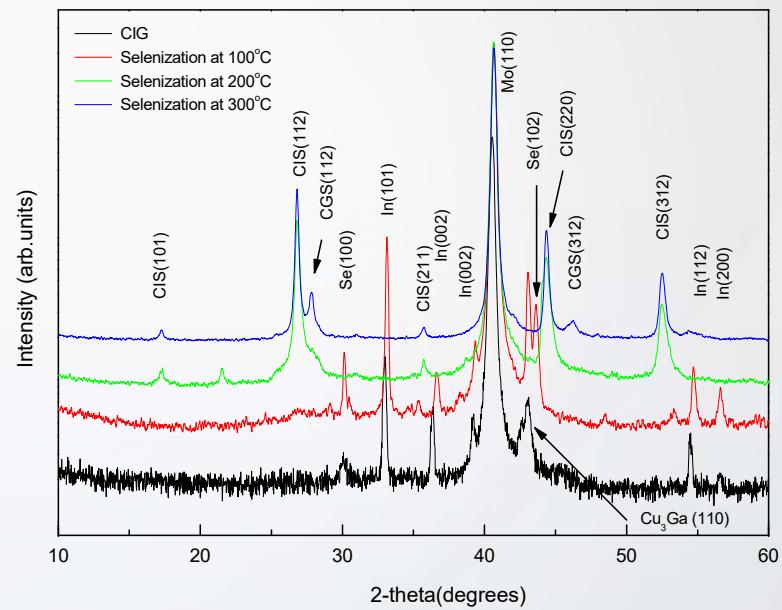
# Performance of Cracker



\* The efficiency of Se cracker is characterized using residual gas analyzer (RGA200, SRS).

# Performance of Cracker

Selenization	Process temp.(°C)	Composition ratio (at.%)			
		Cu	In	Ga	Se
With H <sub>2</sub> Se	450	21.8	23.3	2.9	52.0
With Se cracker	400	20.9	24.2	2.7	52.2
	430	19.3	24.2	3	53.6
	470	22.0	23.6	3.3	51.2
	500	21.0	22.9	3.1	52.9



# Pictures of Effusion cells & Crackers



**Effusion cell**



**Cracker**

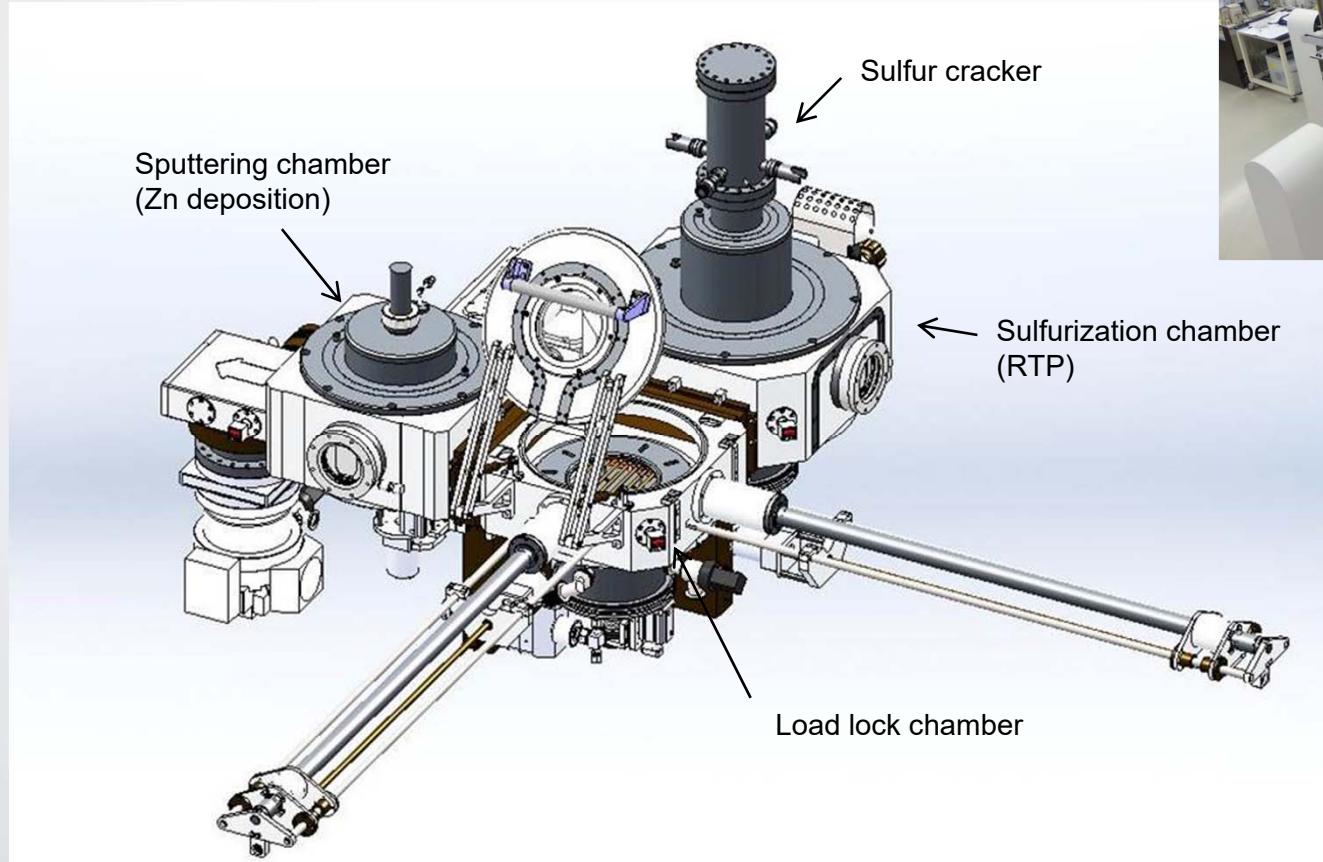


# Pictures of Effusion cells & Crackers



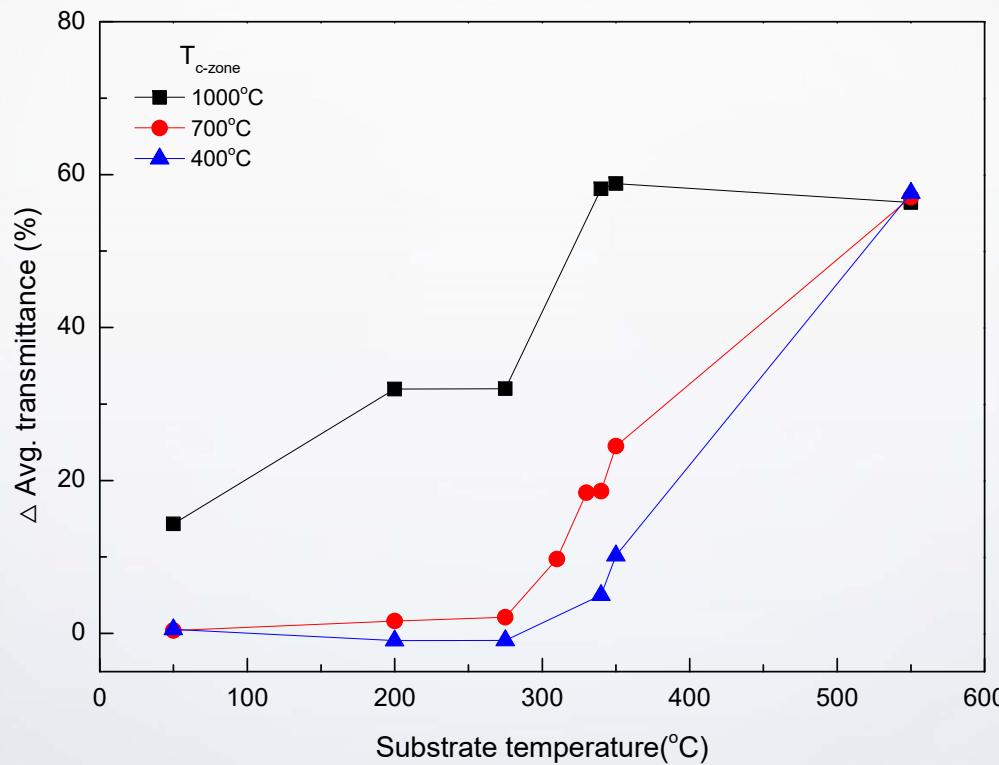
**Effusion cell for mass production**

# PVD System (ZnS RTP system)



# Performance of ZnS RTP system

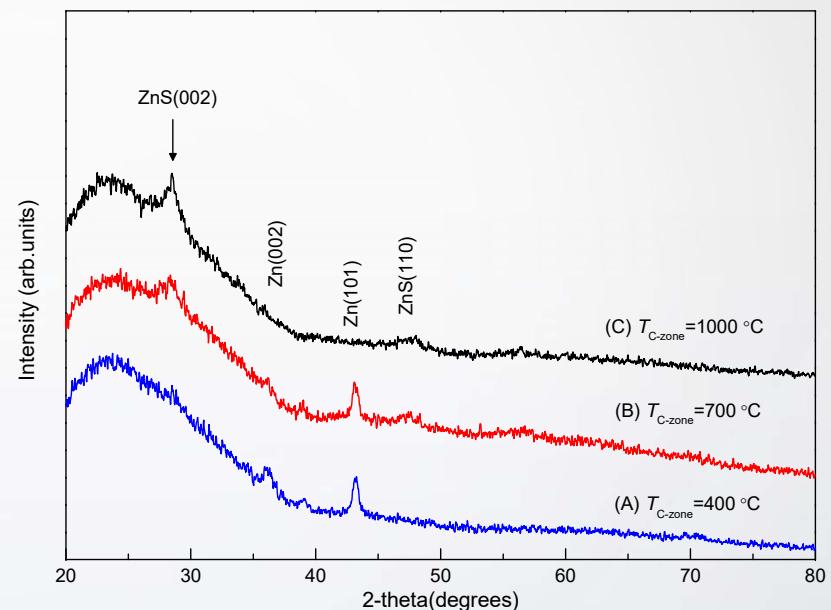
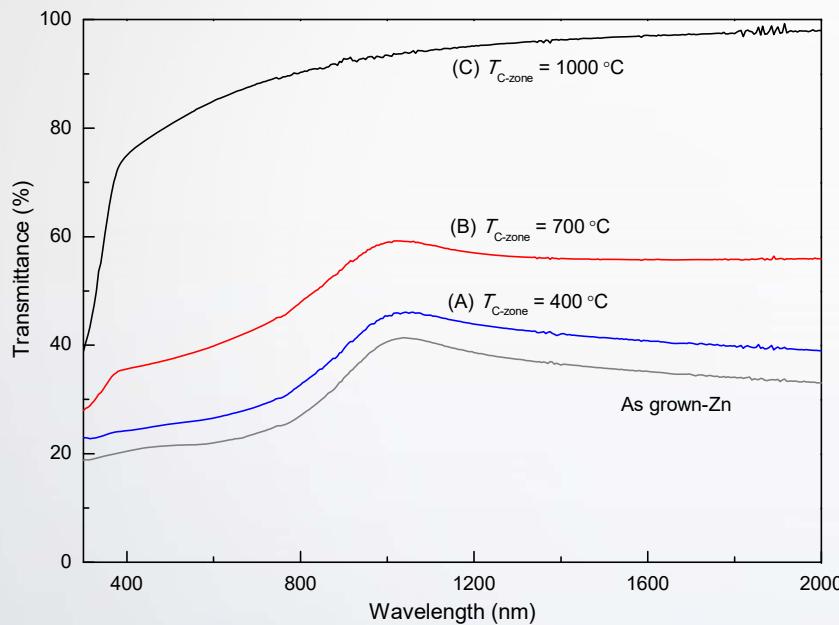
- ZnS buffer layer by ZnS RTP system (Zn film + sulfurization)
  - The change of the average transmittance of the film between before and after sulfurization



\* Ref. J. Mater. Chem. A, 2014, 2, 14593

# Performance of ZnS RTP system

- Influence of c-zone temperature (@ $T_{\text{substrate}}=350\text{ }^{\circ}\text{C}$ )



\* Ref. J. Mater. Chem. A, 2014, 2, 14593

# Contact

JMON Co., Ltd

Tel : +82-42-934-7182 Fax : +82-42-934-7183

E-mail : [jmon@jmon.co.kr](mailto:jmon@jmon.co.kr)

Homepage : [www.jmon.co.kr](http://www.jmon.co.kr)