

Selection of thermal glue

12 Feb. 2018, ITk week



KEK IPNS Manabu Togawa
for the ITk-j pixel group

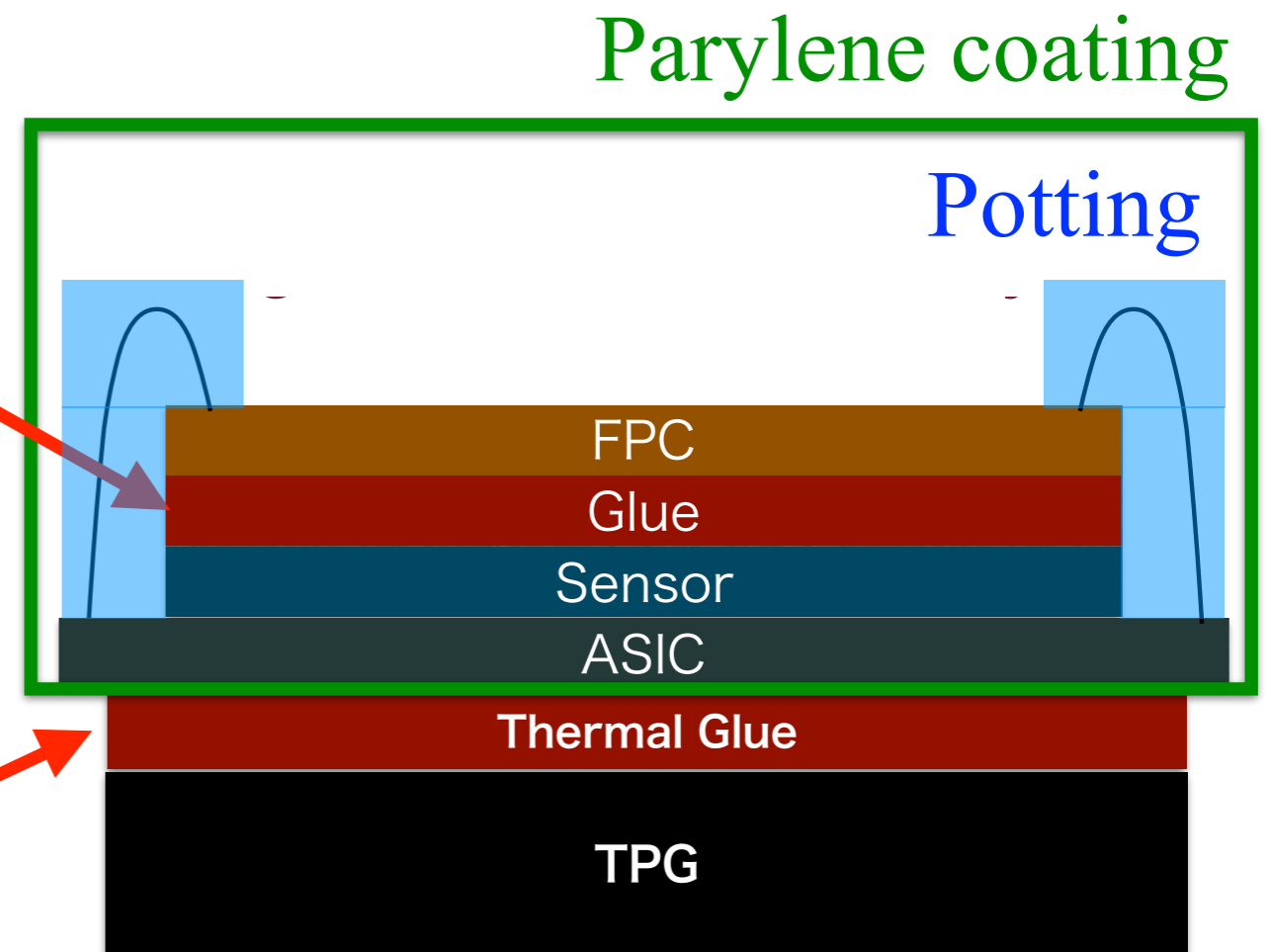


Japan module assembly group :
Shinsuke Ieda, Shuichi Fujino, Kazunori Hanagaki,
Dai Kobayashi, Ryuichi Takashima, Junji Tojo,
Naoki Yamaguchi

Selection of Glues

- Glue btw sensor and Flex
 - Peel strength
 - Proton irradiation
 - Environmental QA

- Glue btw ASIC and TPG
 - should be “Thermal” glue.
 - Think about Parylene coating



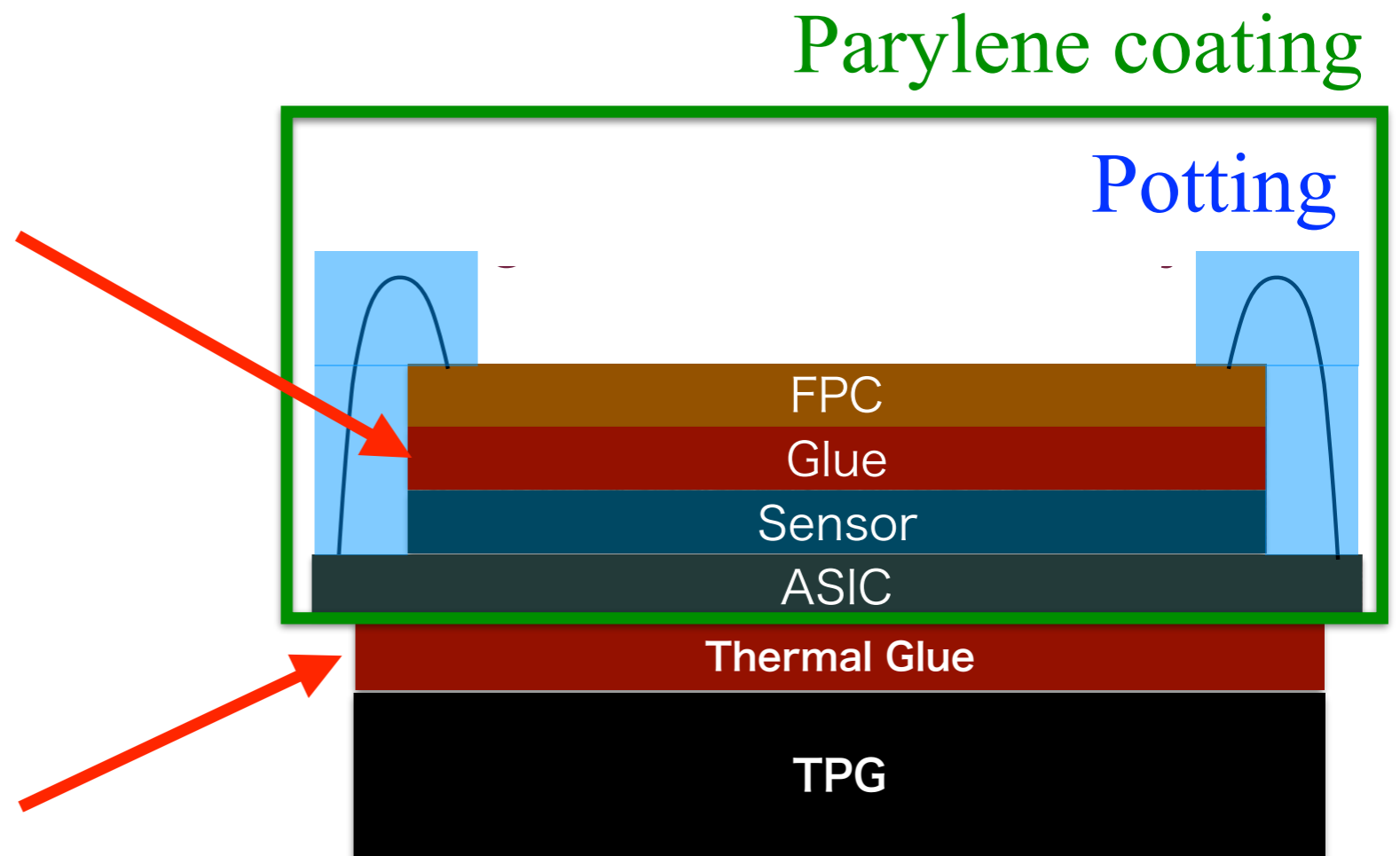
Selection of Glues

- Glue btw sensor and Flex
 - Peel strength
 - Proton irradiation
 - Environmental QA

Araldite 2011
KonishiEM (JP)

- Glue btw ASIC and TPG
 - should be “Thermal” glue.
 - Think about Parylene coating

??



Candidates of thermal glue

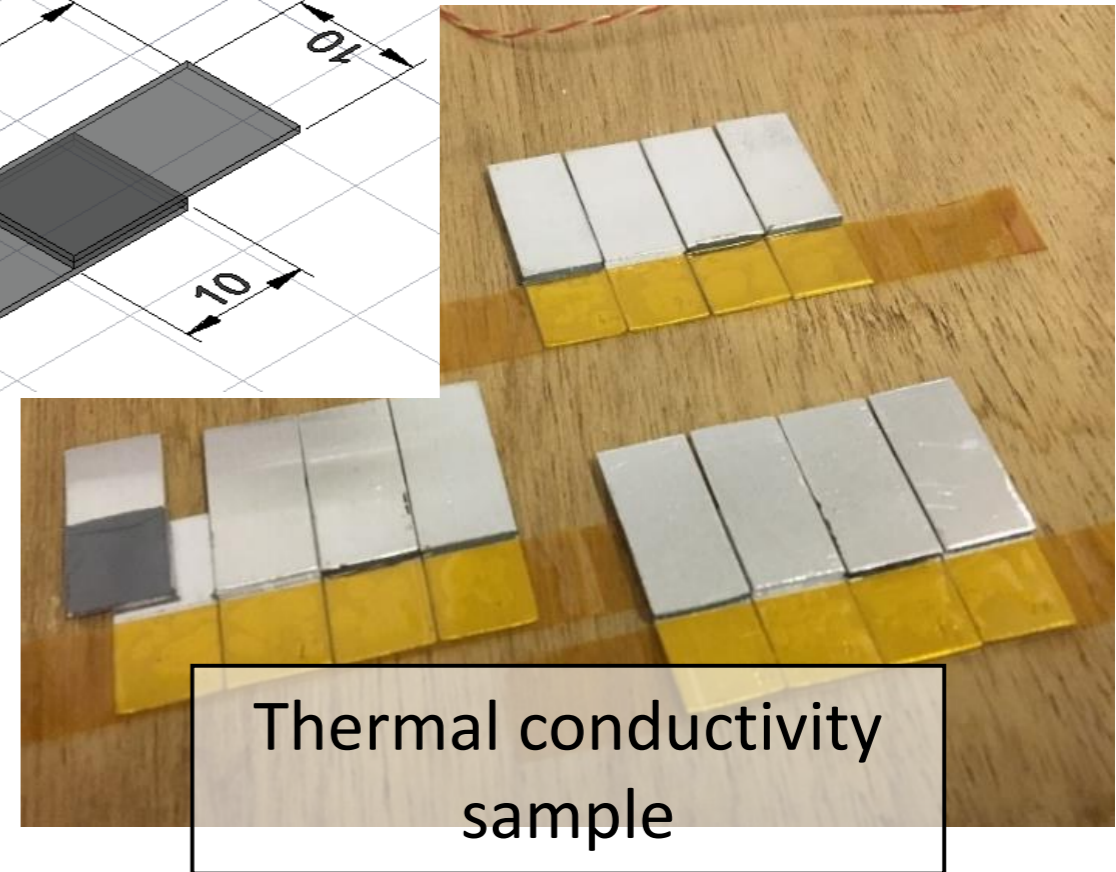
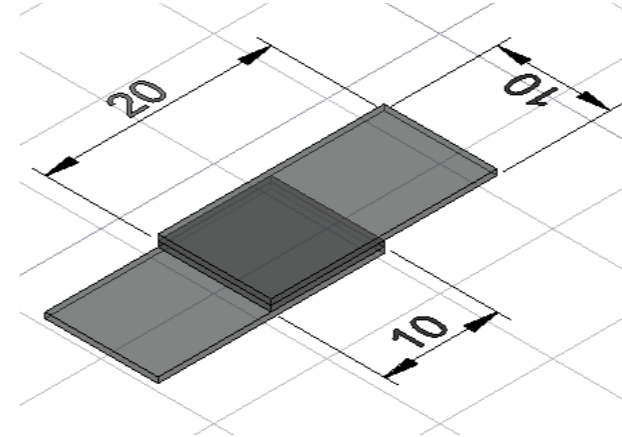
| Glue | Thermal Conductivity (W/mK) | Curing Method |
|--------|-----------------------------|---------------|
| SE4445 | 1.3 | - (Gel type) |
| EG7655 | 1.7 | 4h @ 80 C |
| EG7658 | 3.6 | 4h @ 80 C |

It needs more time with lower temperature.

- Surveyed in terms of
 - Peel strength
 - Thermal Conductivity
 - Proton irradiation
 - Thermal cycle
 - Parylene

Proton Irradiation at CYRIC 2017 Nov.

- Proton energy : 70 MeV
- Irradiated : $0.5 \times 10^{16} \text{ n}_{\text{eq}}/\text{cm}^2$
- Monitored by thin Al plate

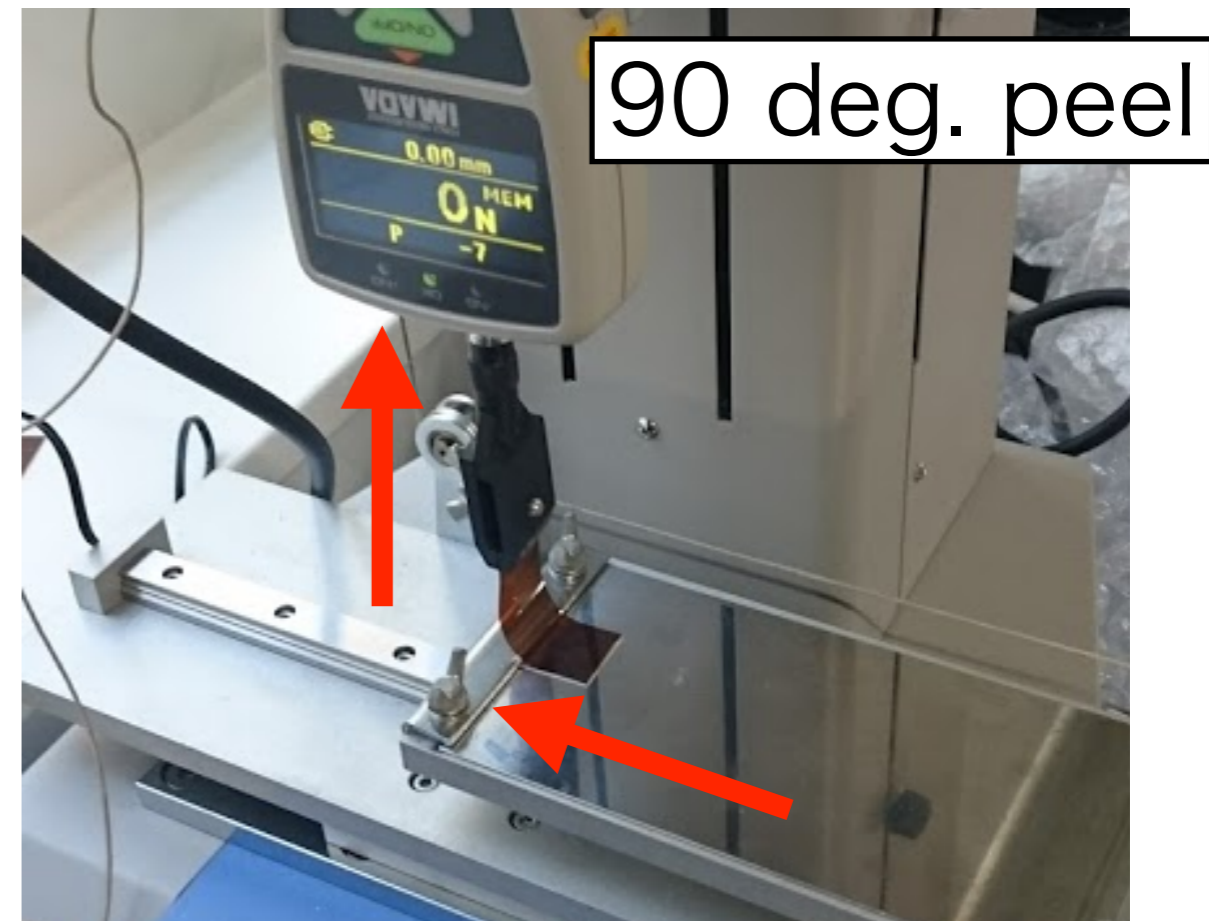


70 MeV Proton



Glue
Sample

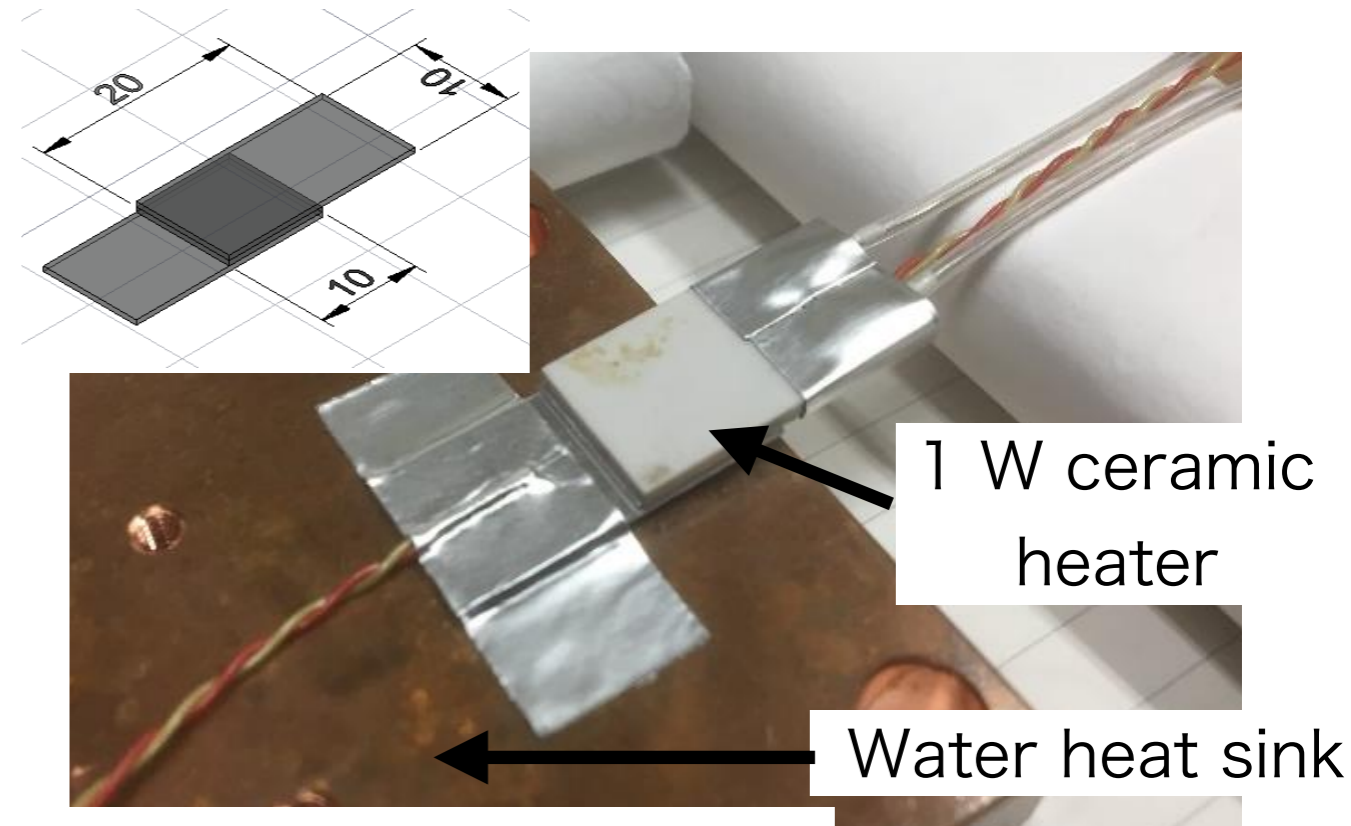
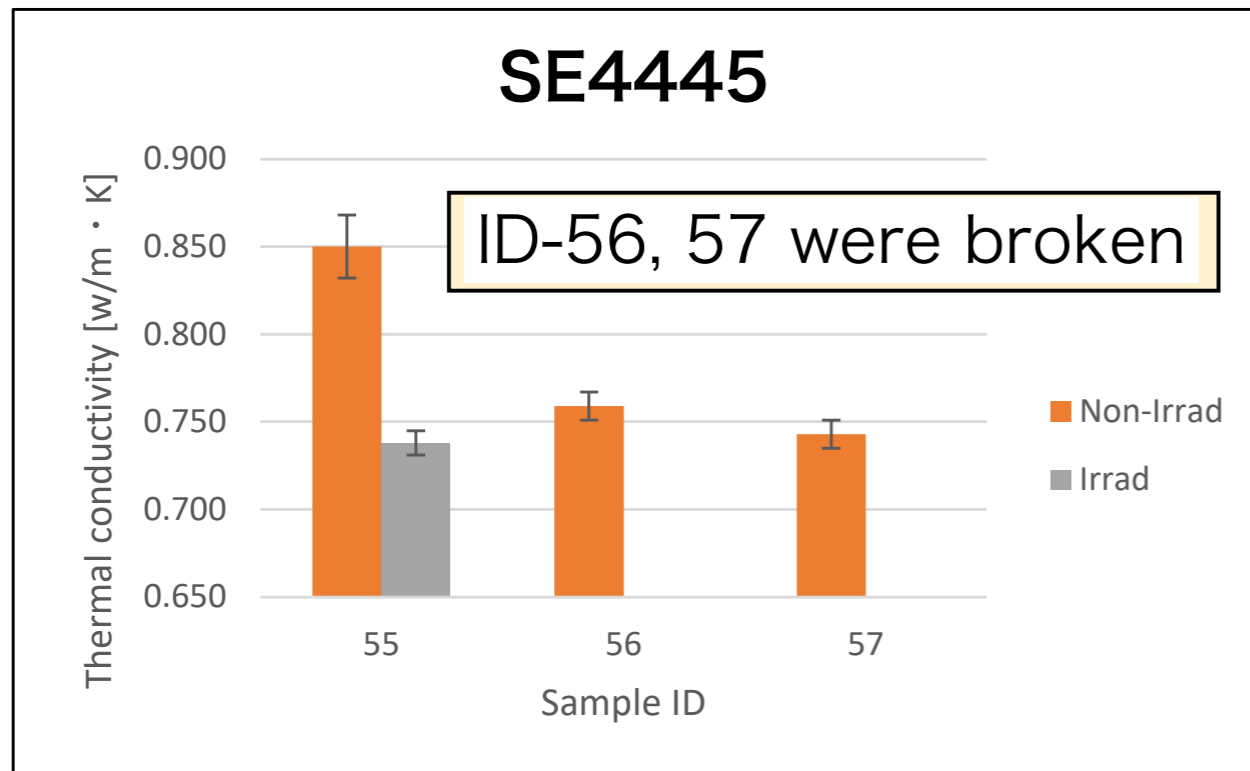
Peel Test before/after Irradiation



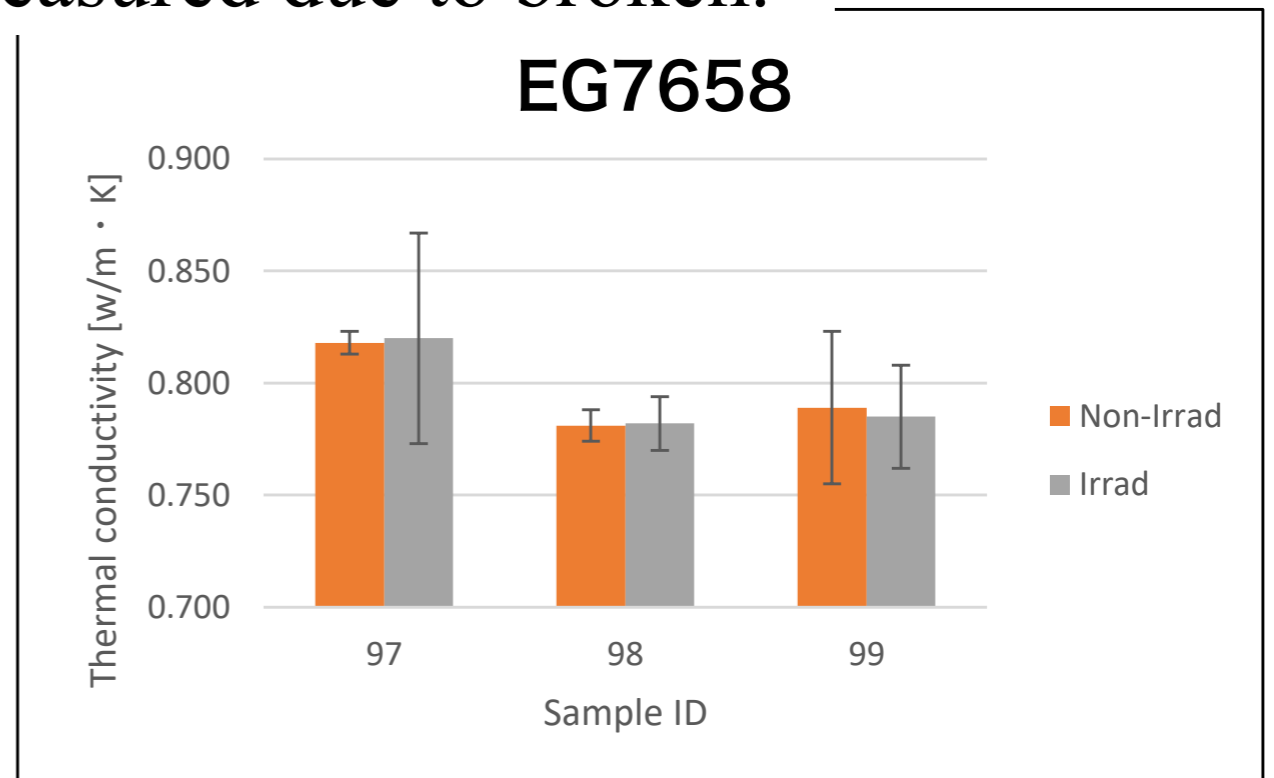
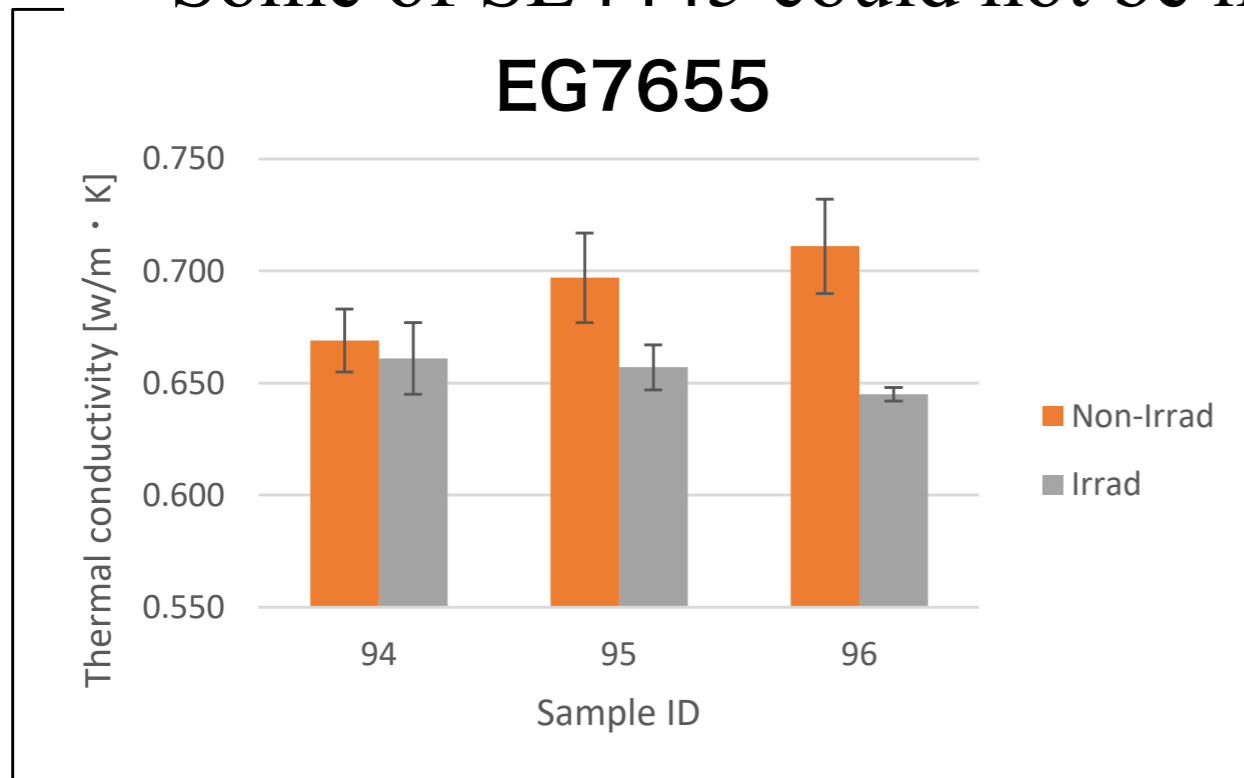
| Condition | SE4445 (N/mm) | EG7655 (N/mm) | EG7658 (N/mm) |
|------------|---------------------------|------------------|------------------|
| Non-irrad. | 0.1 (Soft) | 0.25 ± 0.15 | 0.55 ± 0.05 |
| Irrad. | 0.025 (Dried, Cracked) | 0.35 ± 0.04 | 0.40 ± 0.08 |

- SE4445 are changed to be weak.
- EG series are still keeping enough strength.
- e.g. Non-irradiated Araldite 2011 is 0.2 (N/mm)

Thermal Conductivity before/after Irradiation



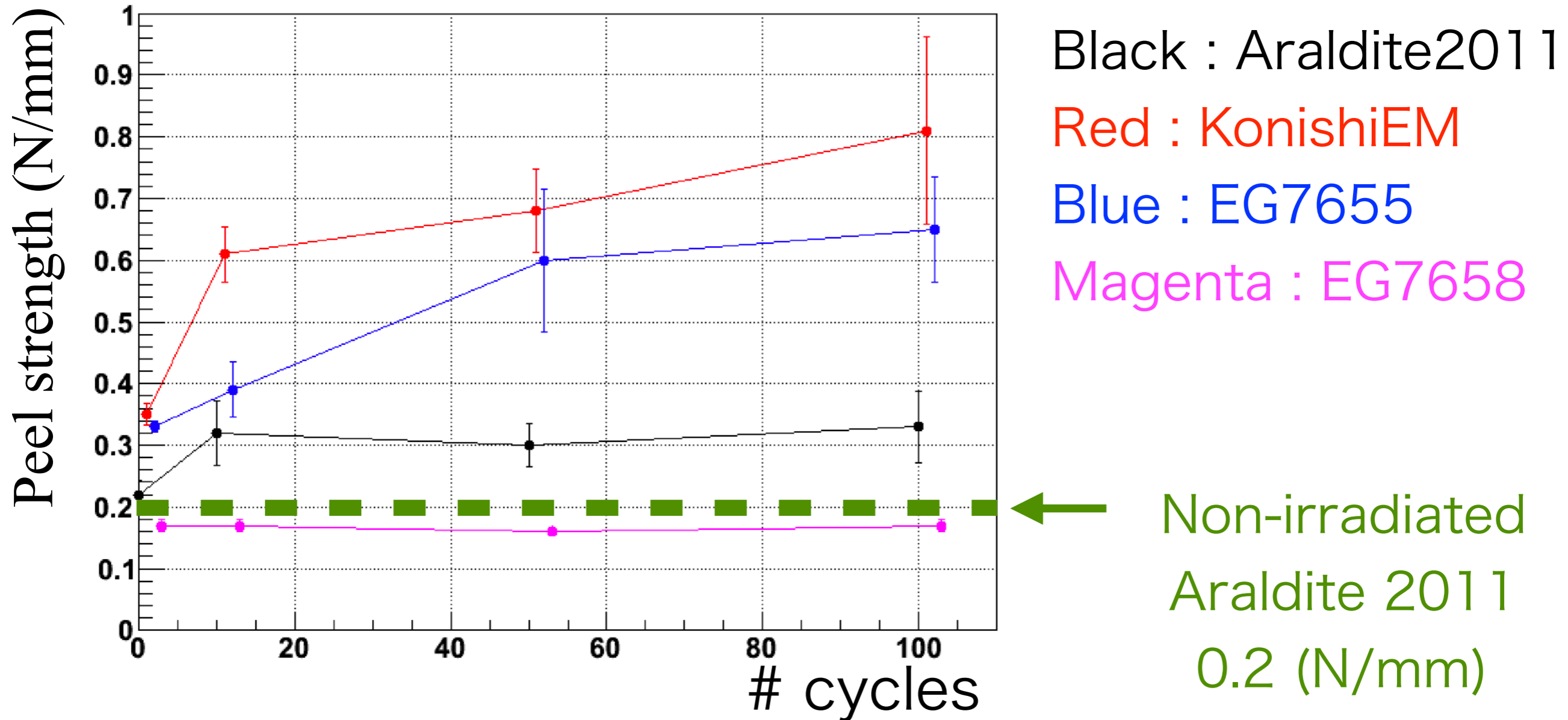
- Some of SE4445 could not be measured due to broken.



- EG series do not significantly change T.C. by irradiation.

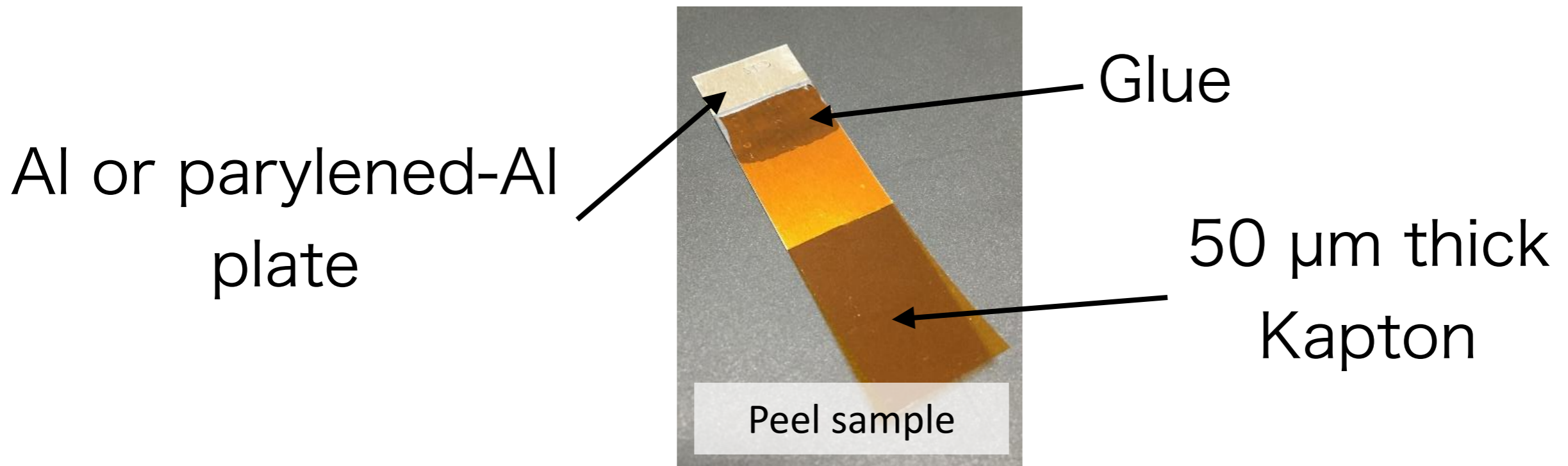
Peel Test before/after Thermal Cycle (including normal glue)

- Thermal cycle range : -55 - 60 C.
- Samples with 0, 10, 50 and 100 cycles.
- KonishiEM and EG7655 are increasing strength.



- EG series have no trouble w/ thermal cycles.

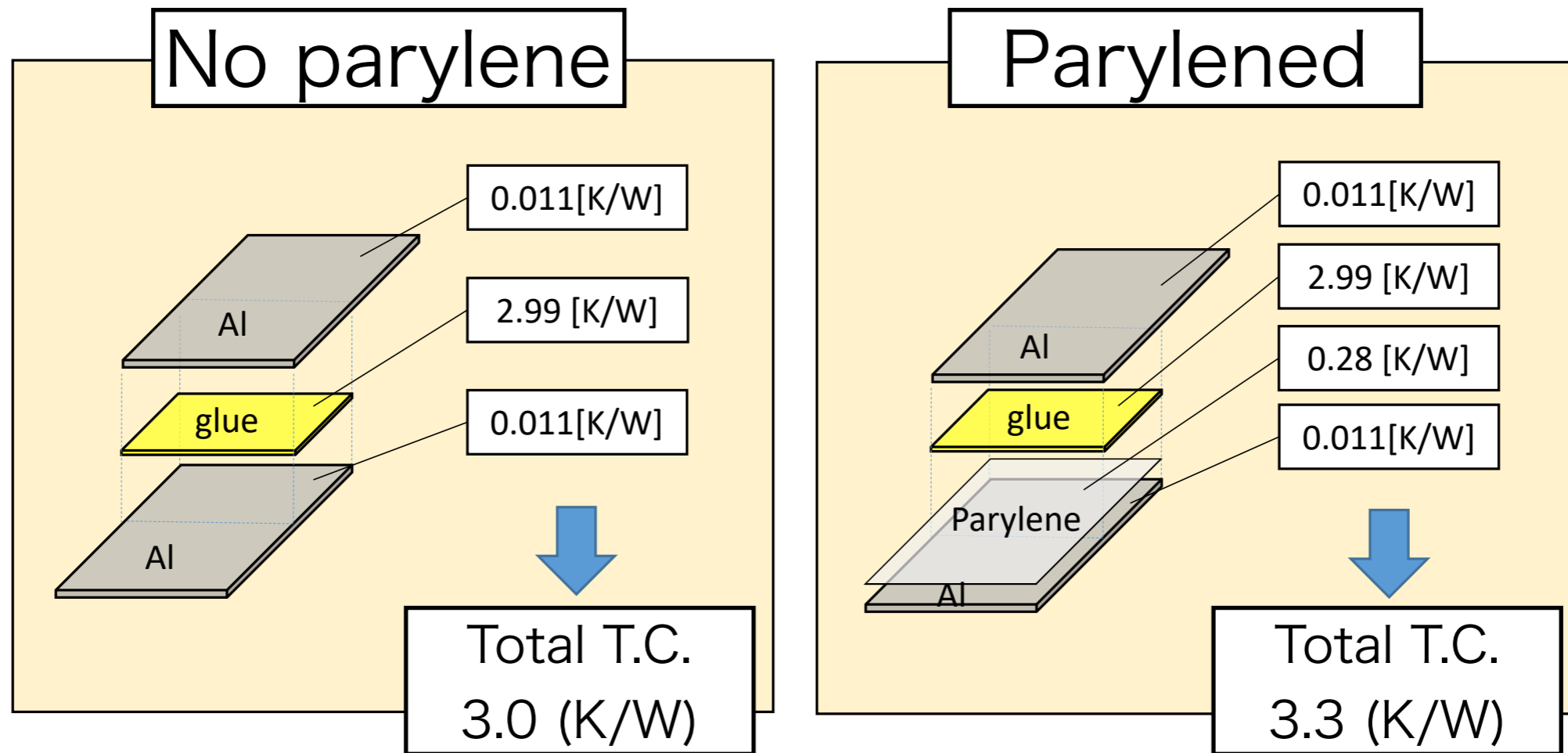
Compatibility with Parylene (Type-n) Peel strength



| Condition | Araldite2011 (N/mm) | EG7655 (N/mm) | EG7658 (N/mm) |
|-------------|------------------------------|------------------|------------------|
| No Parylene | 0.22 \pm 0.04 | 0.33 \pm 0.02 | 0.17 \pm 0.02 |
| Parylened | Easily peeled off by hand | 0.39 \pm 0.07 | 0.37 \pm 0.06 |

EG series have good adhesive level with parylene !

Compatibility with Parylene (Type-n) Thermal Conductivity



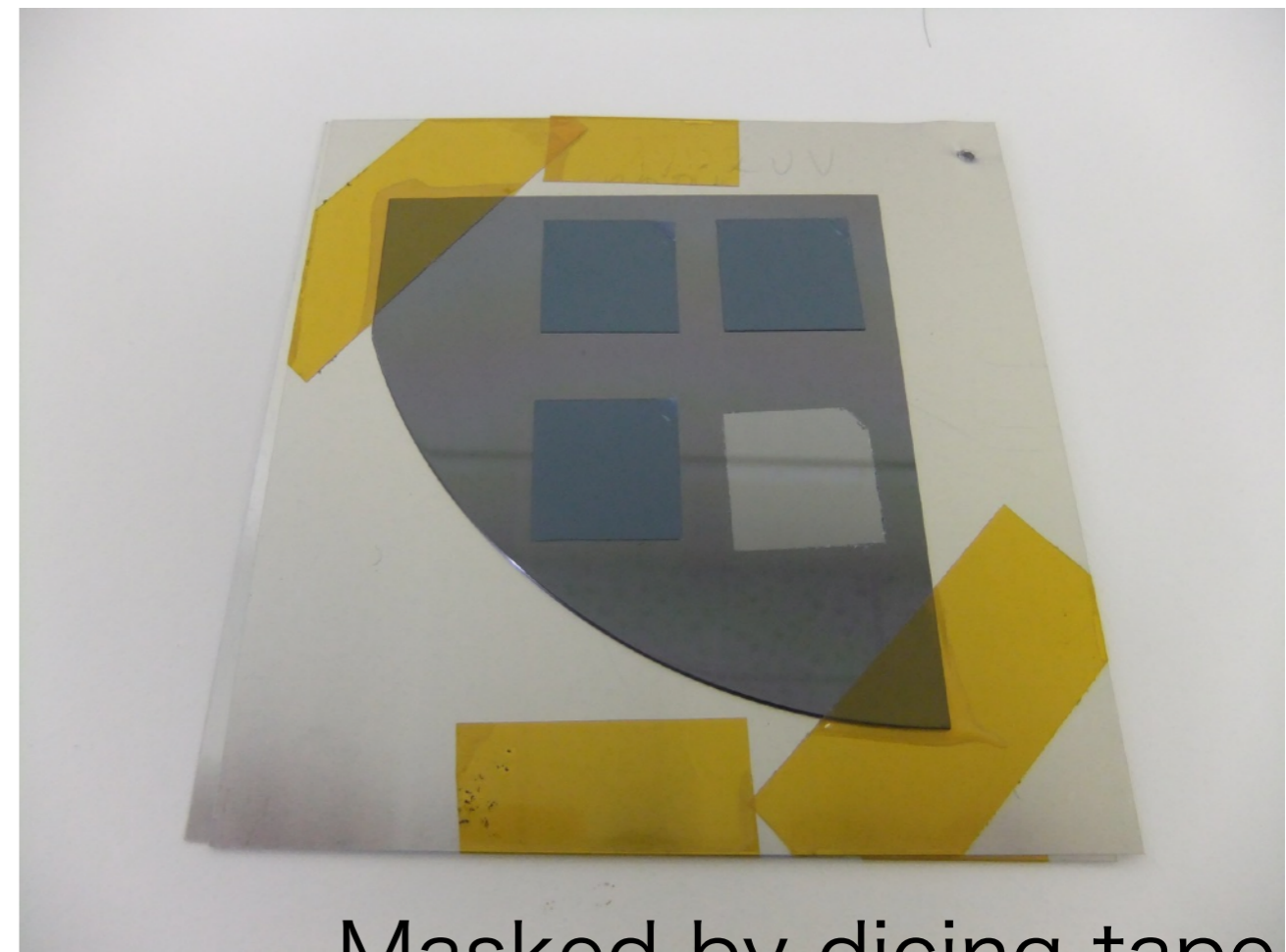
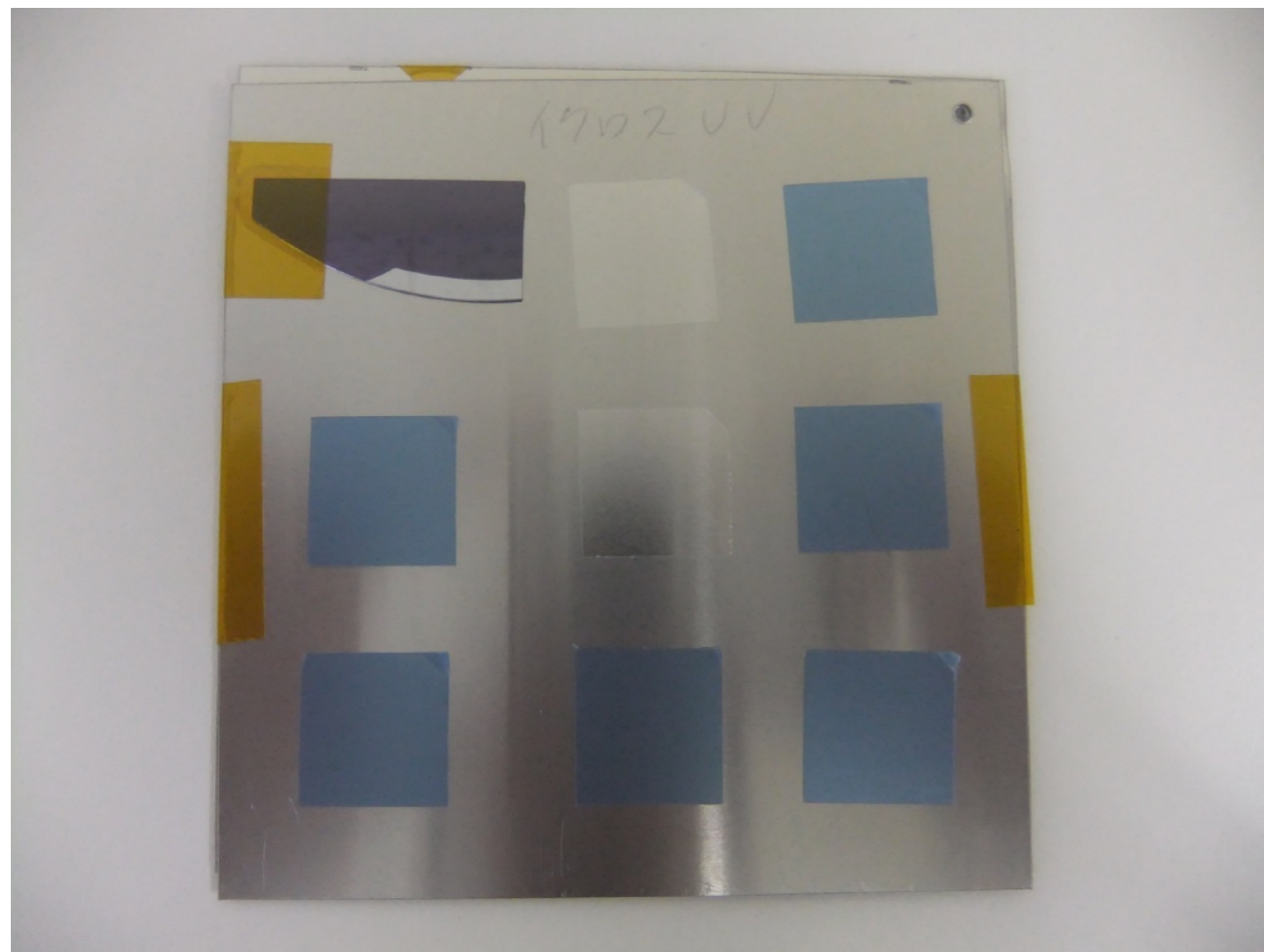
| Condition | T.C. (K/W) |
|-------------|------------|
| No parylene | 5.7 ± 0.5 |
| Parylened | 6.0 ± 0.3 |

EG series are not terrible to parylene

Of course, MASKING is safer choice for Parylene

ITk meeting at Sep. 2017

https://indico.cern.ch/event/609082/contributions/2723392/attachments/1525031/2384270/ITK_Module_JP_20170918.pdf



Masked by dicing tape

- All tapes masked Parylene well.
- By visual inspection and continuity test.

And also it depends on the sequence of assembly.

Conclusion

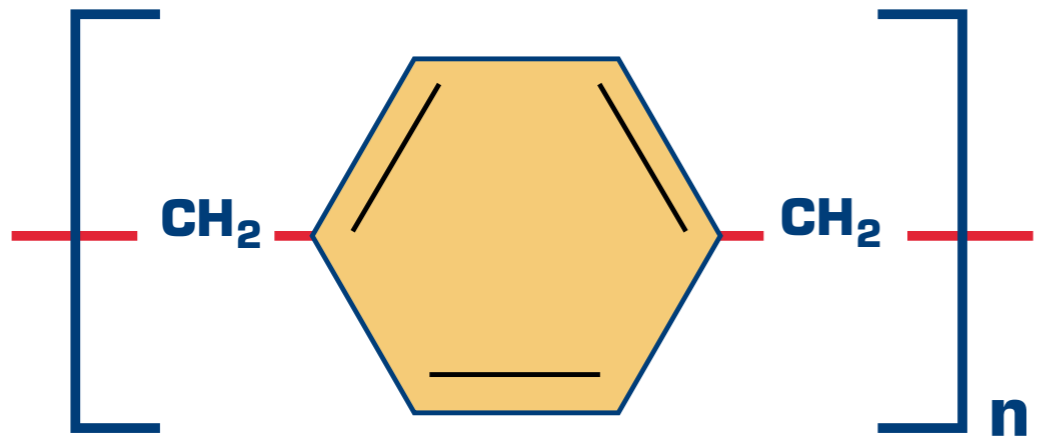
- SE4445 is not applicable for high radiation environment.
- EG7655 and 7658 are good properties for irradiation, thermal cycle and parylene.

Further study

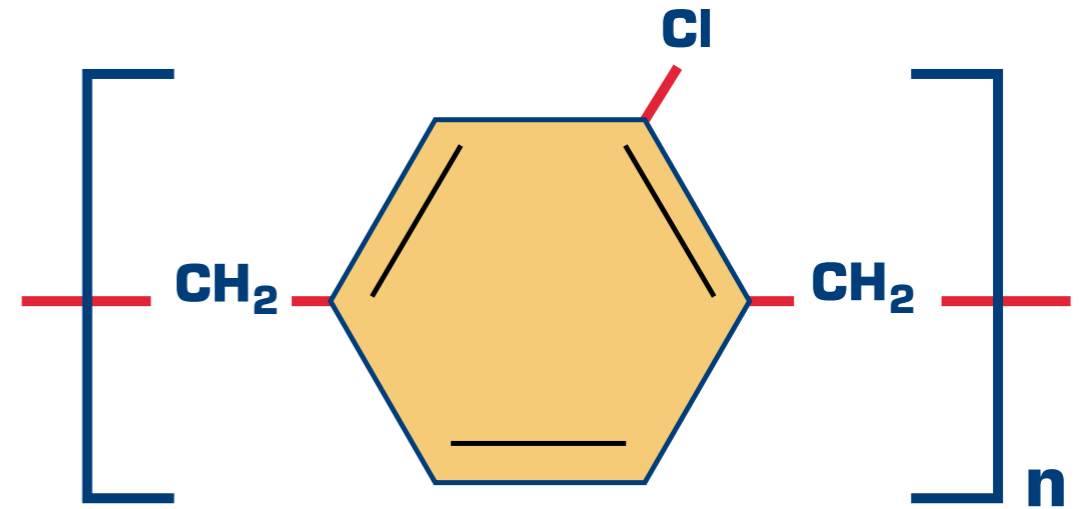
- Thermal conductivity at lower and higher temperature of EG series.
- Another thermal glue ?

Backup

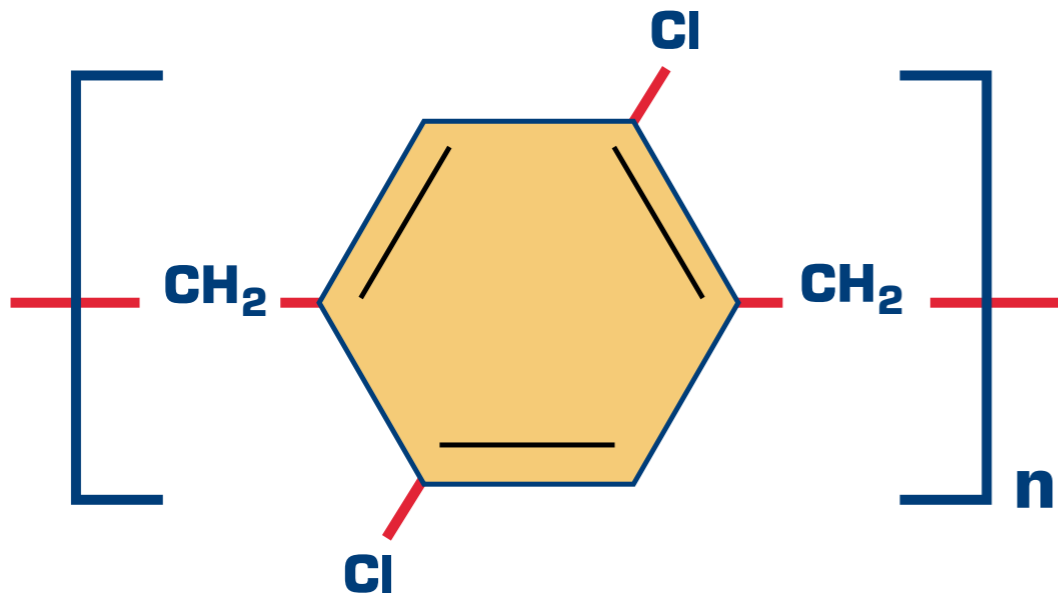
Parylene type



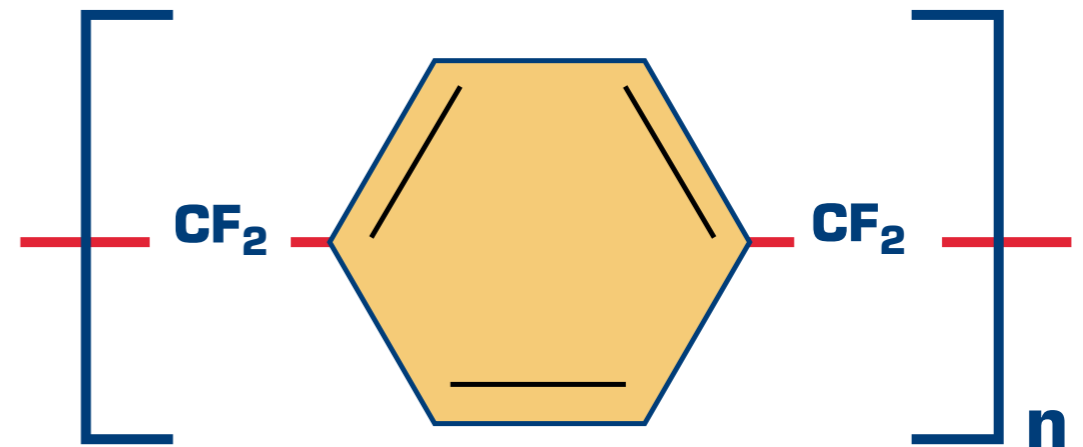
Parylene N



Parylene C



Parylene D



Parylene HT[®]

Target thickness : 7 μm (+- 2 μm)

Peel test before/after thermal cycle

| Thermal cycle | Araldite2011 (N/mm) | Konishi (N/mm) | EG7655 (N/mm) | EG7658 (N/mm) |
|---------------|---------------------|----------------|---------------|---------------|
| 0 | 0.22 ± 0.04 | 0.35 ± 0.04 | 0.33 ± 0.02 | 0.17 ± 0.02 |
| 10 | 0.32 ± 0.09 | 0.61 ± 0.10 | 0.39 ± 0.10 | 0.17 ± 0.02 |
| 50 | 0.30 ± 0.06 | 0.68 ± 0.15 | 0.60 ± 0.26 | 0.16 ± 0.01 |
| 100 | 0.33 ± 0.10 | 0.81 ± 0.34 | 0.65 ± 0.19 | 0.17 ± 0.02 |