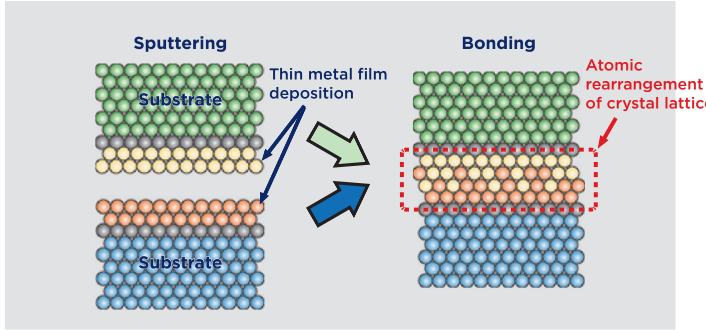
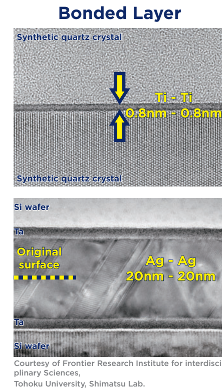
# 3D Integration

## Atomic Diffusion Bonding Technology



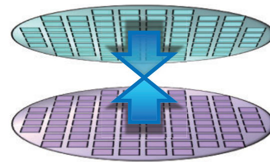

Bonded Layer

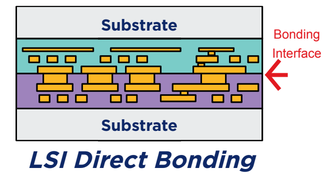



Courtesy of Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Shimatsu Lab.

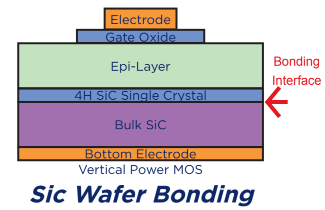
✓*Almost any metal can be used as bonding layer!*

**SiC + SiC**
**Piezoelectric + Si**
**3D Integration**






***LSI Direct Bonding***




***Sic Wafer Bonding***

NEW!

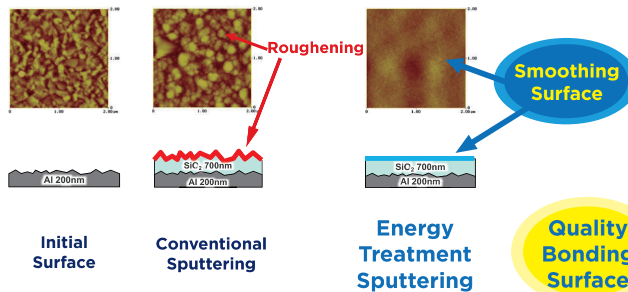
BC7000

***Development Road Map***

| | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|
| Substrate Size | Φ100mm, Φ150mm (Available now) | | | |
| | | Φ200mm, Φ300mm | | |
| Alignment Accuracy | < 0.15mm | | | |
| | | < 1.0μm | | |
| | | | < 0.1μm (*Hybrid Bonding 3D Integration*) | |

## Bonding Capable Smooth Surface

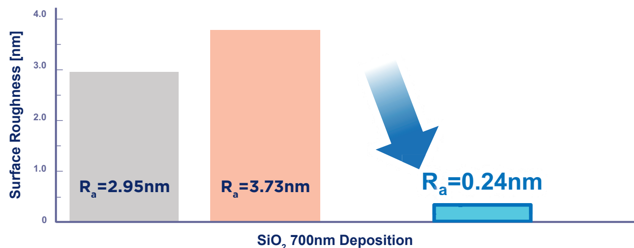
### ✓ To Make Roughening Surface Flat by Deposition




Initial Surface | Conventional Sputtering | Energy Treatment Sputtering | Quality Bonding Surface

NEW!

**EC7420**
**Energy Treatment Sputtering Equipment**



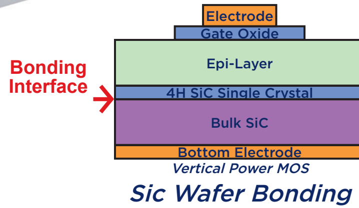

| Specifications | |
|---|---|
| Planetary Substrate Holder | Φ4“ 5 wafers/batch<br>Φ6“ 4 wafers/batch |
| Deposition Uniformity | WIW < ±1%*1 |
| Deposition Rate | >30 nm/min *2 |

*1 Φ4" Si wafer
*2 Smoothing surface process

# Power Device Solution

## SiC Wafer Bonding

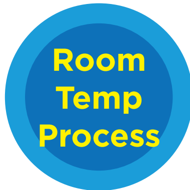
### BC7000
### Atomic Diffusion Bonding Equipment



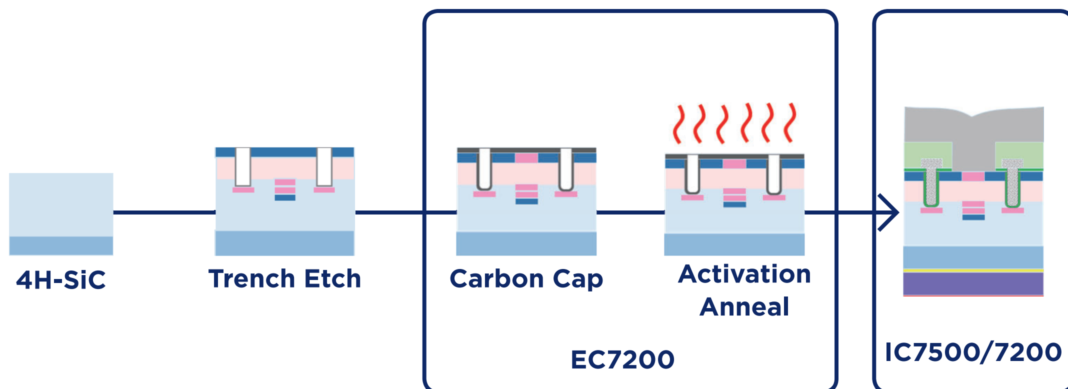

*Sic Wafer Bonding*

| Specifications | |
|---|---|
| Base Pressure | 5 x $10^{-7}$ Pa |
| Deposition Uniformity*1 | WIW < ±2%<br>WTW < ±1.5% |
| Particles | 0.3~0.5µm ≤ 20<br>0.5~1.0µm ≤ 10<br>1.0µm~ ≤ 10 |
| Alignment Accuracy (3σ) | XY < ±0.3mm<br>θ < ±0.3° |
| Throughput | ≥ 17wph |

*1 Measurement points : 6" wafer EE10mm



## SiC Trench MOSFET Process




### EC7200
### SiC Carbon Cap and Activation Anneal

| The Surface Roughness | |
|---|---|
| Initial | 1800°C/5min |
| RMS=0.16nm | RMS=0.19nm |
| - | AR*1=100% |

*1 AR: Activation Ratio (Al implant: 7E+17/cm³)

**Extremely flat surface and perfect activation**

### IC7500/7200
### Sputtering Process for SiC Device

| Metallization Materials | |
|---|---|
| p/n-Contact Metal | Al, Ti, Ni |
| Back Surface Contact Metal | Ti, Ni |
| Interconnect | Ti, Al |
| Back Side Electrode | Ti, Ni, Au |
| Pad Electrode | Ti, Ni, Au |
| Schottky Electrode | Ti, Mo |