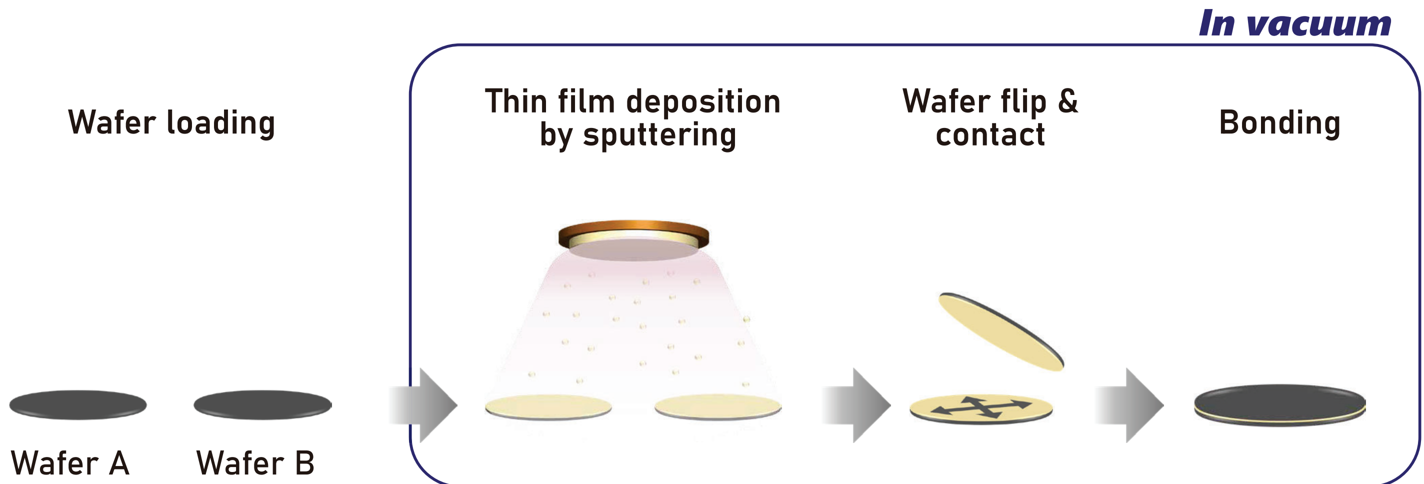
# Atomic Diffusion Bonding

## as Permanent wafer bonding at room temperature

## Wafer Bonding Process Flow




- ✓ Room temperature bonding
- ✓ Any substrates available
- ✓ Various bonding materials

## Bonding Film Materials

Blue : Bonding confirmed
Pink : Theoretically possible

| H | | | | | | | | | | | | | | | | | He |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Li | Be | | | | | | | | | | | B | C | N | O | F | Ne |
| Na | Mg | | | | | | | | | | | Al | Si | P | S | Cl | Ar |
| K | Ca | Sc | Ti | V | Cr | Mn | Fe | Co | Ni | Cu | Zn | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | Y | Zr | Nb | Mo | Tc | Ru | Rh | Pd | Ag | Cd | In | Sn | Sb | Te | I | Xe |
| Cs | Ba | La | Hf | Ta | W | Re | Os | Ir | Pt | Au | Hg | Tl | Pb | Bi | Po | At | Rn |
| Fr | Ra | Ac | Rf | Db | Sg | Bh | Hs | Mt | Ds | Rg | Cn | Nh | Fl | Mc | Lv | Ts | Og |

- ✓ Using various oxide, nitride, or carbide films, bonding can be achieved.
- ✓ Bonding films allow various functions to be incorporated at the interface.

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## Using Various Metal Films

### As a contact metal

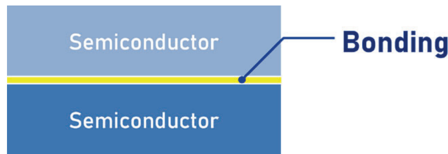



Fig.1 Engineered Substrate

### As a thermal conductive layer

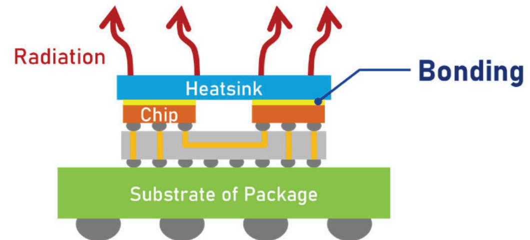
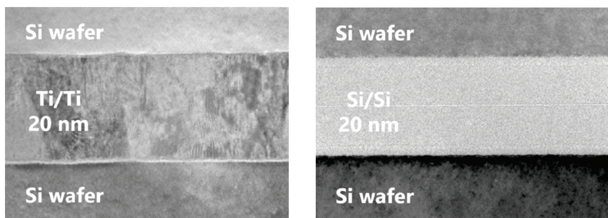



Fig.2 2.5D Packaging




* Courtesy of Shimatsu Laboratory, Tohoku University

| | ADB (Metal interlayer) | Solder bonding |
|---|---|---|
| Thermal Conductivity [W/mK] | 154 | 50 *1) |
| Bonding layer [µm] | 0.11<br>Ta (5 nm) / Au (50 nm) on each side | 50 *1) |
| Thermal Resistance [m²K/W] | $7.1\times10^{-10}$ | $1.0\times10^{-6}$ |

*1) Thickness & thermal conductivity of the solder bonding is estimated value

### Reliable conductive bonding

### Innovative heat management for high performance devices

## Using Various Dielectric Films

### As a thin isolation layer

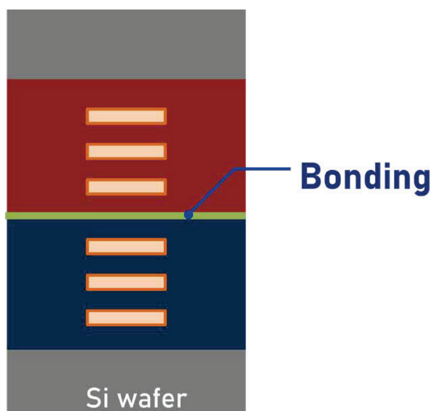
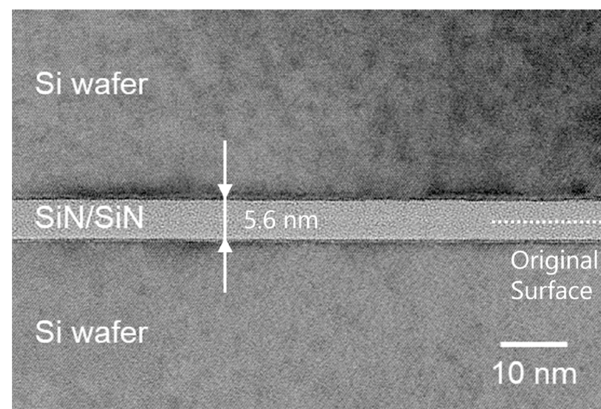



Fig.3 CFET Structure




### Ideal for future advanced logic device