Internal stress measurement of thin film

− 75～300 mmΦ size and dependence on temperature −

Internal stress of thin film can be determined by substrate bending, one of the method for stress measurement in our company. By using this method, temperature dependence of internal stress and stress distribution of thin film can also be clarified. We have two detecting types such as laser non−contact type and stylus one.

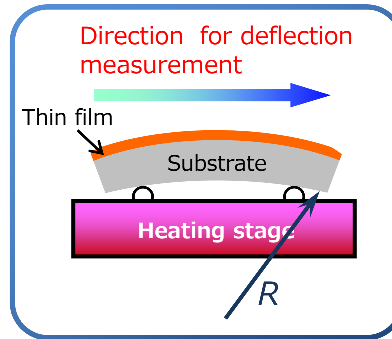
Substrate bending method

- Substrate size : 3～12 inches [75～200 mmϕ]
- Temperature range : -65～500℃ [300 mmϕ :only at room temperature]
- Detecting type: Laser non- contact type or stylus type.

Required parameters for stress calculation

- Substrate : Thickness, Elastic modulus, Poisson's ratio and crystal orientation(in the case of Si wafer.)
- Thin film : Thickness

Internal stress is calculated from the difference of curvature before and after film deposition, and using material properties of thin film and substrate.



Equipment of internal stress by substrate bending

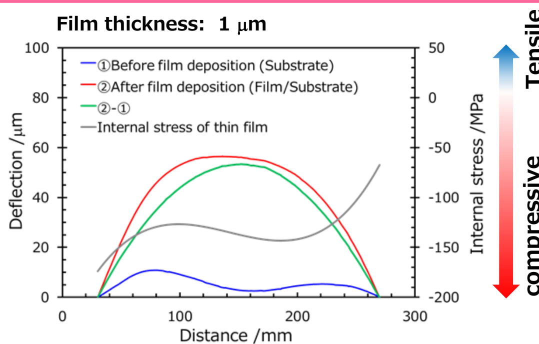
$$\sigma_f = \frac{1}{6}\,\frac{E_s}{(1-\nu_s)}\,\frac{t_s^{2}}{t_f}\left(\frac{1}{R_1}-\frac{1}{R_0}\right)$$

σ : Stress
E : Elastic modulus
ν : Poisson's ratio
t : Thickness

R : Radius
(R_1 : Before film deposition, R_0 : After film deposition)

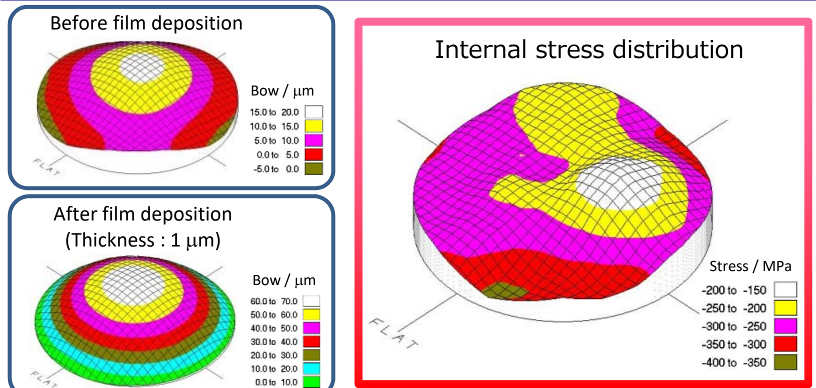
Suffix f : Thin film, s : Substrate

Deflection and internal stress of SiN thin film on 300mm ϕ Si wafer



The substrate shows a convex shape due to the SiN film deposition. The mean stress of the SiN film is -130 MPa.

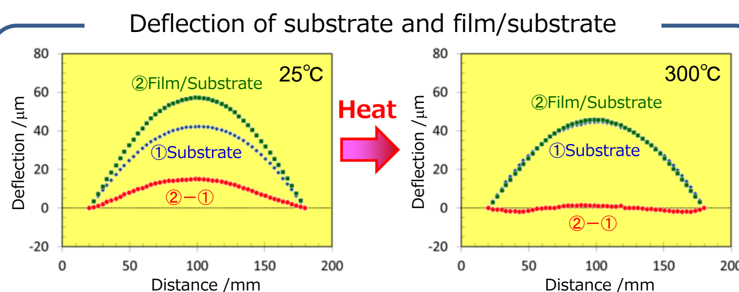
Distribution of deflection and internal stress in SiO_2 thin film on 200 mm ϕ Si wafer



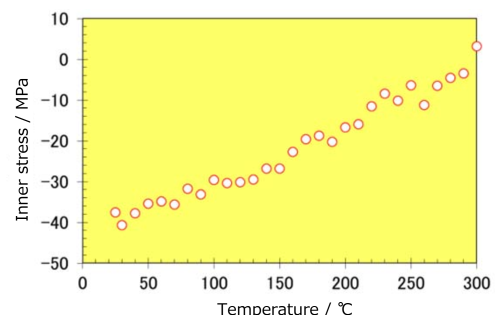
Deflection and internal stress map can be obtained(200 mmϕ and room temperature only).

Temperature dependence of internal stress

Sample : SiO2 thin film on Si substrate (film thickness: 1 μm)



At 25℃, there is a significant difference between substrate and the film/substrate, while the difference between two is quite small at 300℃.



Internal stress (absolute value) decreases with rising temperature.

We can calculate the coefficient of thermal expansion (CTE) of thin film from the temperature dependence of the internal stress, physical properties of the thin film and substrate.

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