CONTROL OF STRESS

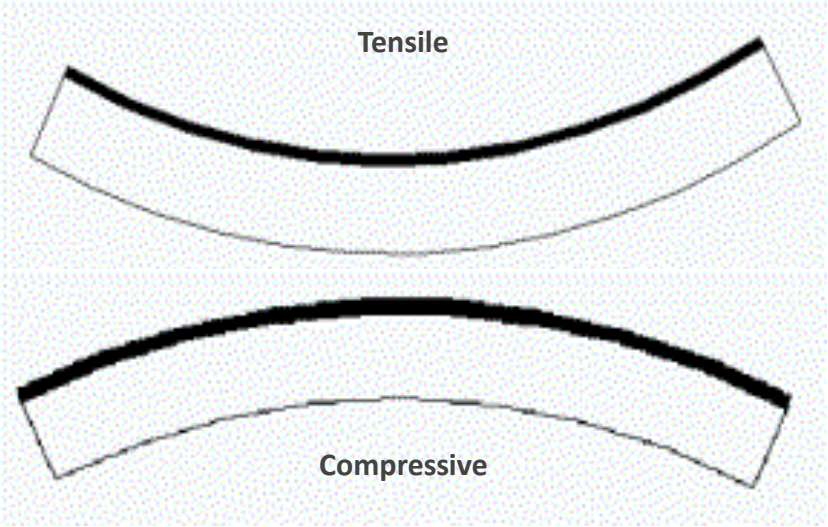
In Corial PECVD SYSTEMS

CORIAL PECVD
STRESS CONTROL

CORIAL
A Plasma-Therm Company

MECHANICAL STRESS DEFINITION

PECVD



‘Film density’ is lower than the normal value for a selected material

The stress is **‘tensile’** or **‘positive’**

‘Film density’ is higher than the normal value for a selected material

The stress is **‘compressive’** or **‘negative’**

MECHANICAL STRESS CONTROL

PECVD

Mechanical stress in the PECVD films is driven by the film 'density' and therefore can be controlled by:

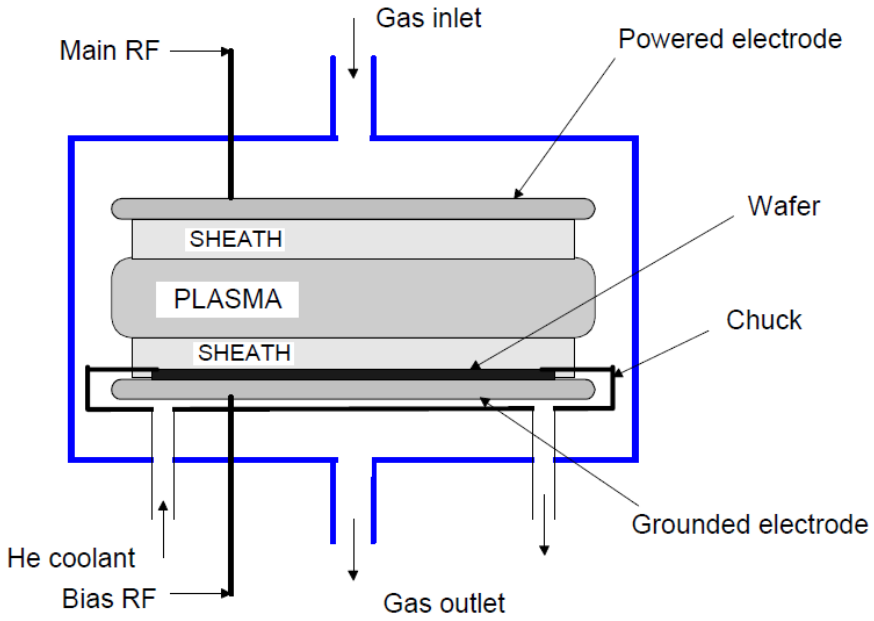
- Composition of films, and hence process conditions (gas composition, pressure)
- Ion bombardment of films during their growth

ION BOMBARDMENT

PECVD

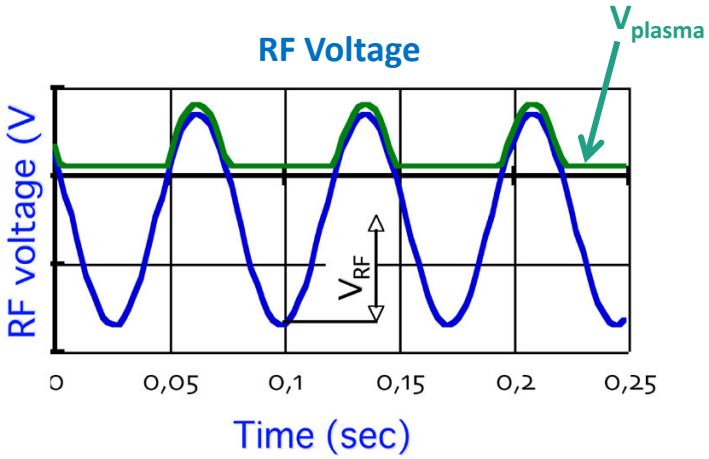
Basic PECVD reactor:

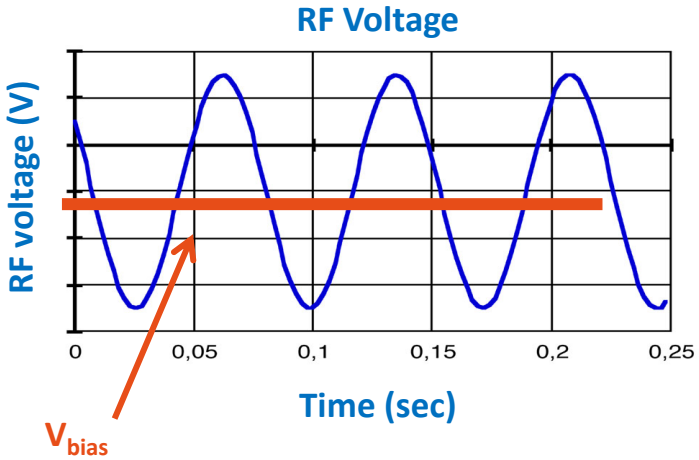
A 13.56 MHz voltage is applied between two electrodes. Electrons, accelerated by the high frequency electric field, ionize the molecules of gas



ION BOMBARDMENT

PECVD





Depending on the process conditions (pressure, gas composition, RF power) plasma volume will become positively charged to the ground (plasma potential, V_{plasma})

If RF voltage is applied to the substrate holder, then the negative bias voltage will appear (V_{bias}).

ENERGY OF IONS COMING TO THE SURFACE IS:

$$E = e \cdot (V_{PLASMA} + V_{BIAS})$$

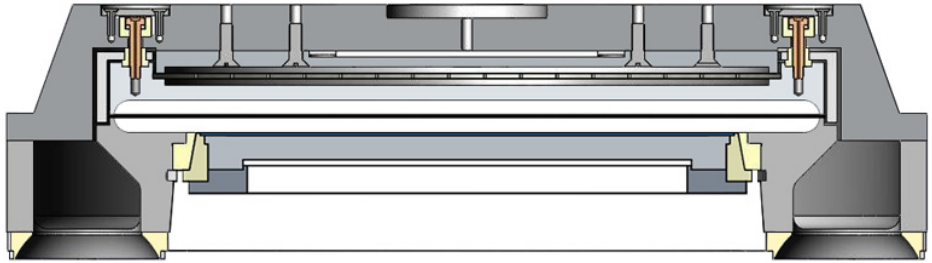
PECVD REACTOR

CORIAL Symmetrical Design

Cathode area

=

Anode area



Due to the similarity of cathode and anode areas in case of CORIAL reactor, the V_{plasma} value becomes high.

Simultaneously, no V_{bias} is created on the substrate holder.

As a result,

Ion energy is equal to

$e \cdot V_{plasma}$

Depending on process conditions

V_{plasma} can reach several hundreds Volt,

thus providing necessary bombardment for

stress control

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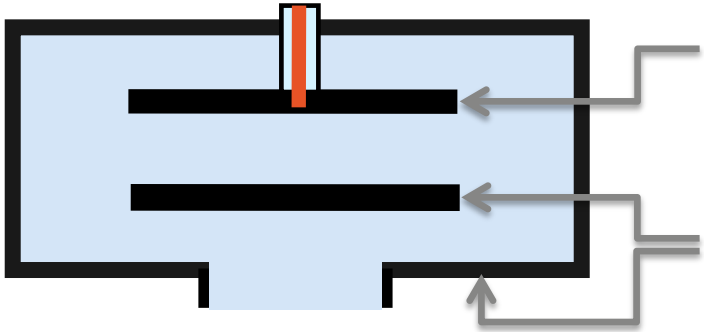
CORIAL PECVD REACTOR VS. STANDARD PECVD

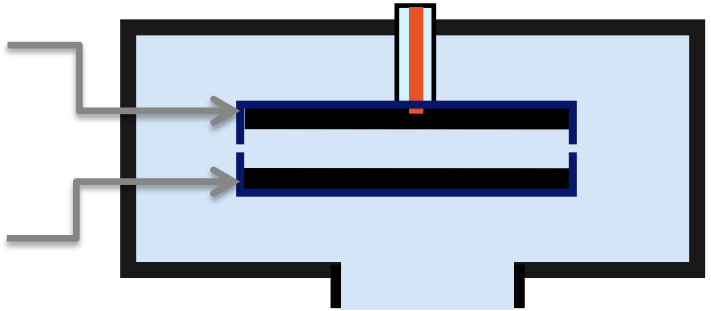
Standard PECVD



Anode area >> Cathode area

- Self bias voltage on cathode (V_{DC}) >> 100 V
- Mean plasma potential = (V_{RF} – V_{DC})/2 (≈ few Volts)
- Low energy ion bombardment on wafers sitting on the anode (ground)

CORIAL Pressurized Reactor

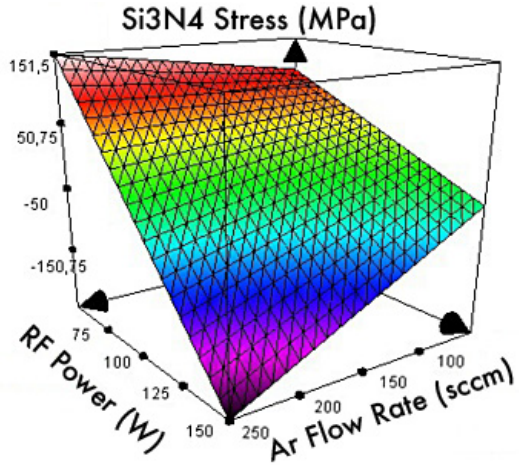


Anode area = Cathode area

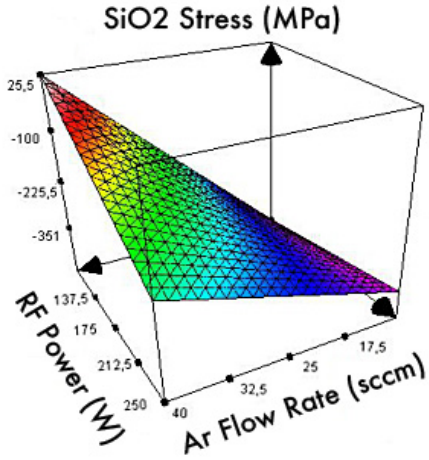
- Self bias voltage on cathode (V_{DC}) = 0V
- Mean plasma potential = V_{RF} / 2 (Few hundred volts)
- High energy ion bombardment on wafers sitting on anode

CORIAL PECVD REACTOR

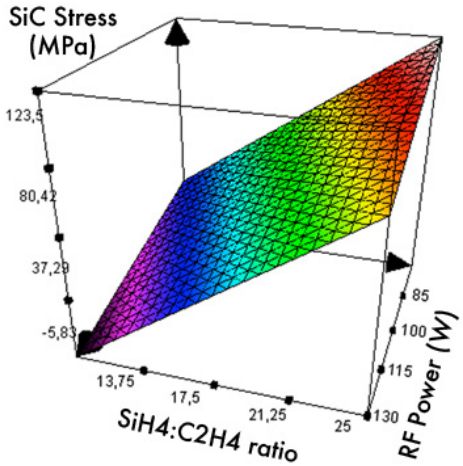
Stress controlled in a wide range by RF power, Ar flow rate and gas mixture in a very simple and reproducible manner



Si_xN_y with tunable stress



SiO_2 with tunable stress



SiC with tunable stress

CORIAL PECVD STRESS CONTROL

Some data showing the range of mechanical stress obtained with CORIAL PECVD

Material	*Substrate*	**Stress** *(MPa)*	**Deposition rate** *(nm/min)*	**Refractive Index**	**BOE rate** *(nm/min)*
SiO_2	Si	-484	79	1.46	115
	Si	32	426	1.48	190
Si_3N_4	Si	-706	93	2.06	-
	Si	-365	80	2.07	40
	Si	243	48	1.91	144

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