SiC on Oxford PECVD 4

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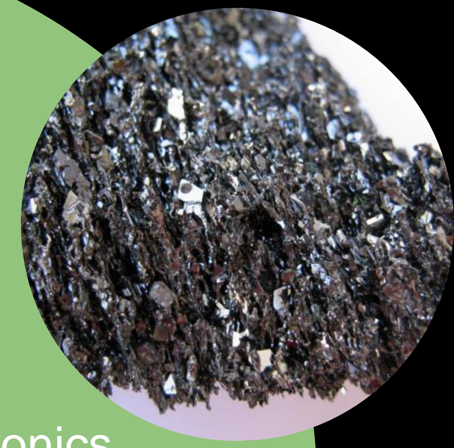
Background

SiC

- Often used as an abrasive
  - Car Brakes, Bullet Proof Vests
- used in semiconductor electronics devices that operate at high temperatures or high voltages
  - Solar panels, electronics used in space
- Has an index of about 2.64
- Semiconductor



- How is it normally made?
  - 800C
  - In Tystar 15

PECVD

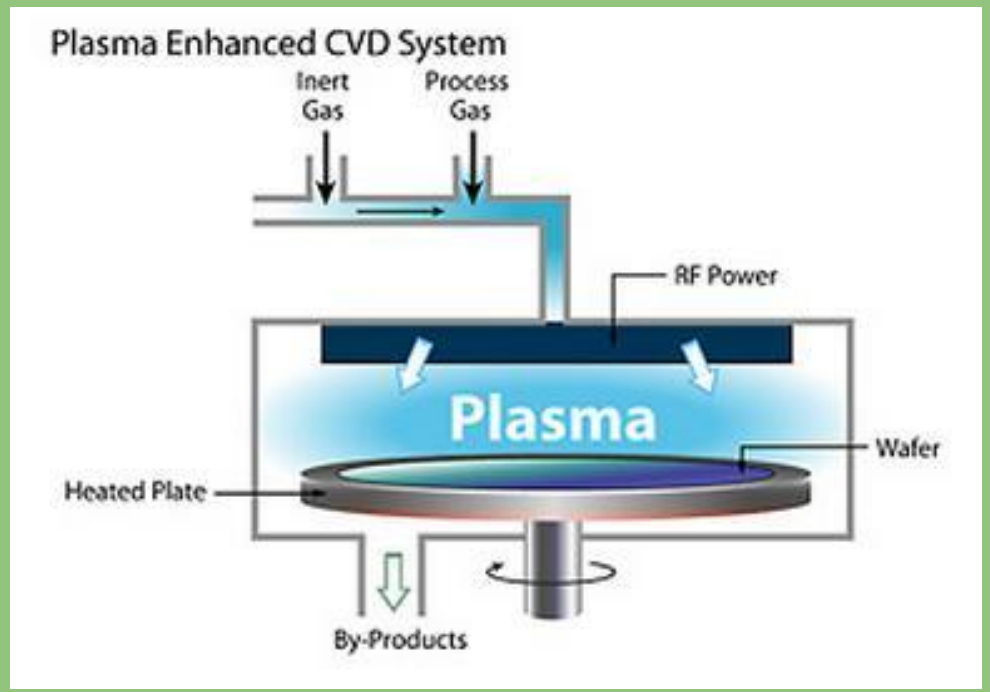
- process used to deposit thin films from a gas state (vapor) to a solid state on a substrate.

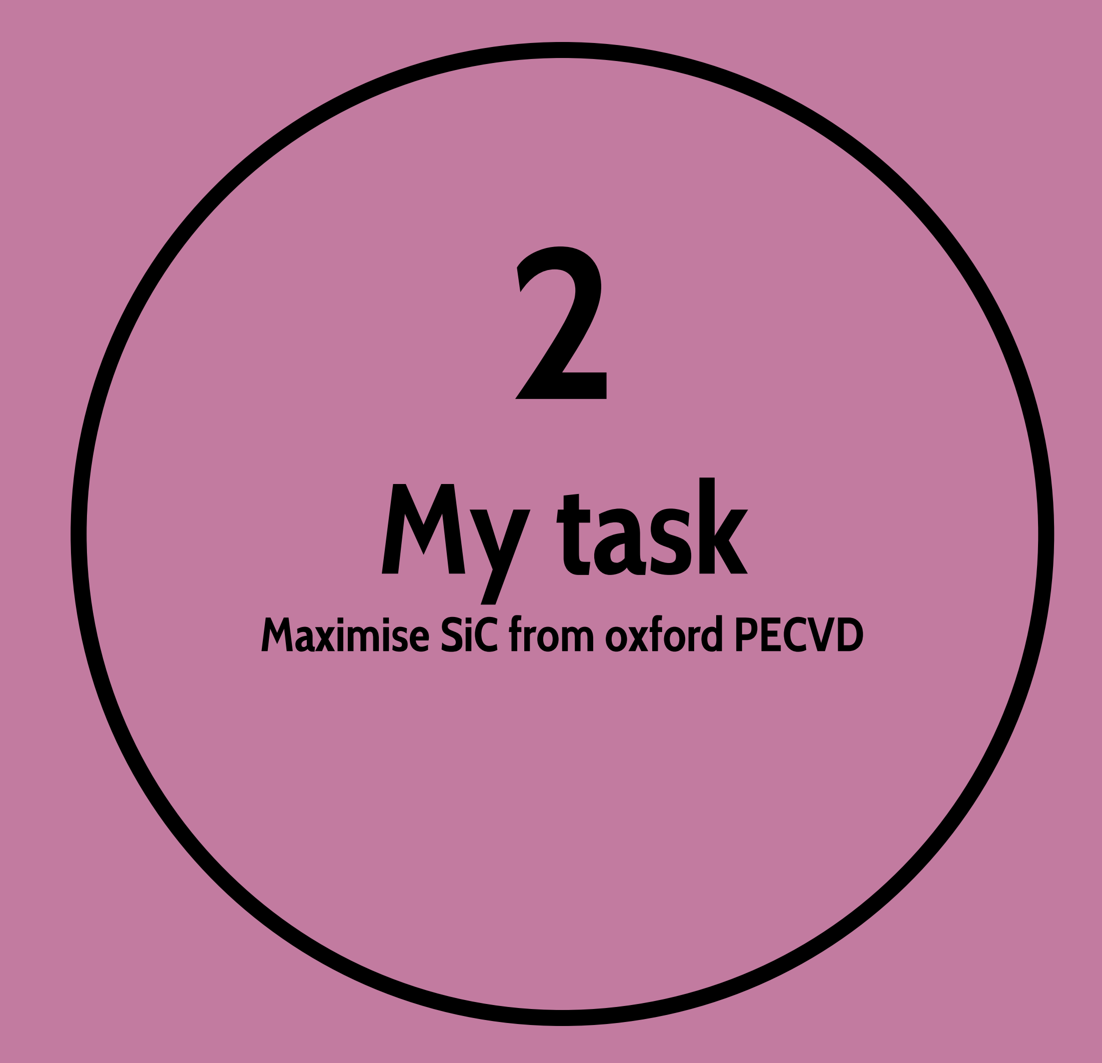
Chemical Reaction

$$CH_4 + SiH_4 \rightarrow SiC + 4H_2$$

How does it work ?

- RFuses AC power (switches between plus and minus)
    - Create a Plasma
- Flows gas
- Pressure inside chamber
- Heated plate

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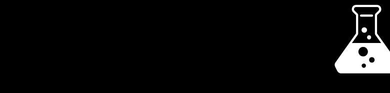
My task
Maximise SiC from oxford PECVD

Original recipe

- 30 min deposition time (reasonable time)
- 350 degrees Celsius (Good Crack)
- 300mT pressure(Low to High)
- 50 W of power (Low to high)
- 30 sccm of CH4(Higher activation energy)
- 7.5 sccm of SiH4



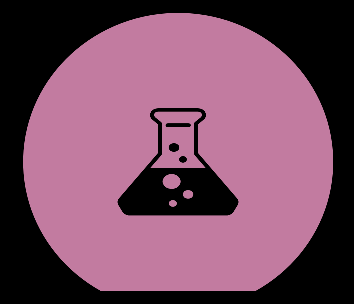
Measurements

Thickness

SEM, ellipse

Refractive Index

Ellipse, Nanoduv

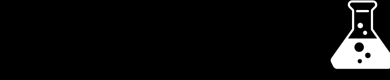


Why (refractive)index?

Refractive index is a measure of bond quality. Higher index is good. It means a more crystalline structure.

Amorphous: 1.8

Polycrystalline: 1.9-2.5



Measurements

Stress

FLexus

Etch
test

Msink 7

Tencor
DUAL WAVELENGTH

SPECIAL
APPLICATION
HEATED BATH
msink7
DANGER
ACID

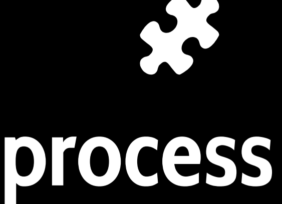
Measurements

- **Type of bonds**

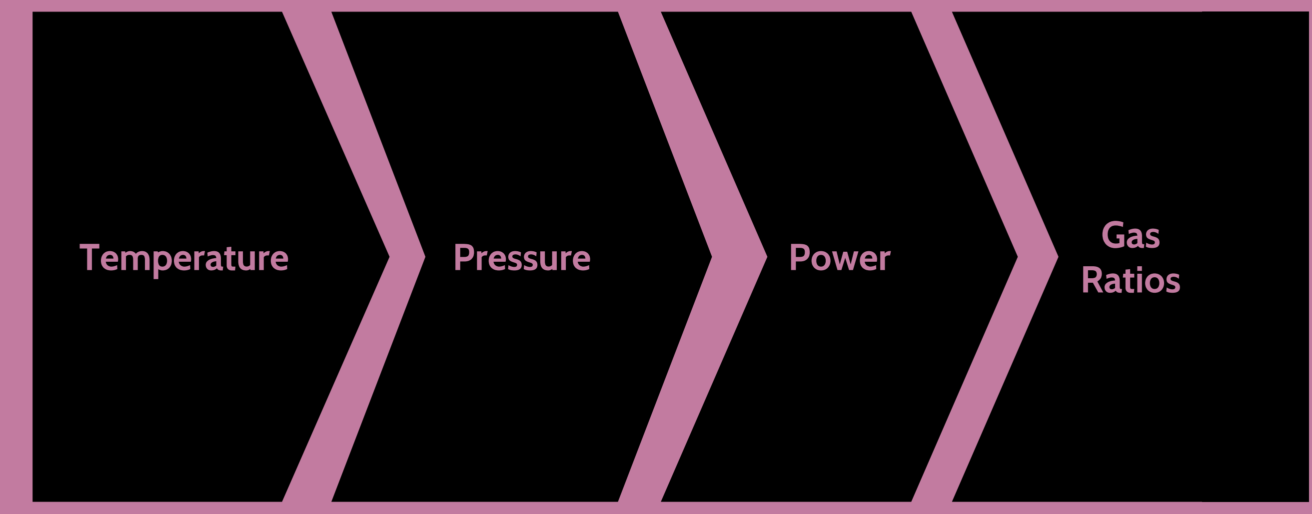
  FTIR

- **Sheet resistance**

  ResMap

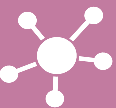


process



Why change what we did?

Dep rate= (pressure of SiH4)(pressure of CH4)(velocity of CH4/SiH4)(reaction x-section)(e^(-activation energy/k*Temperature))



This equation came from plugging manipulated ideal gas law into the thermal equilibrium equation

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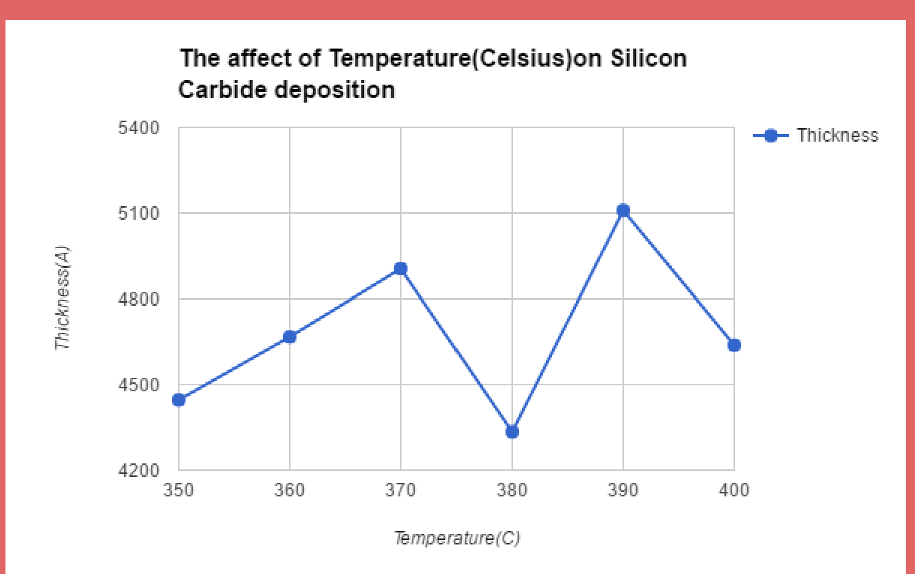
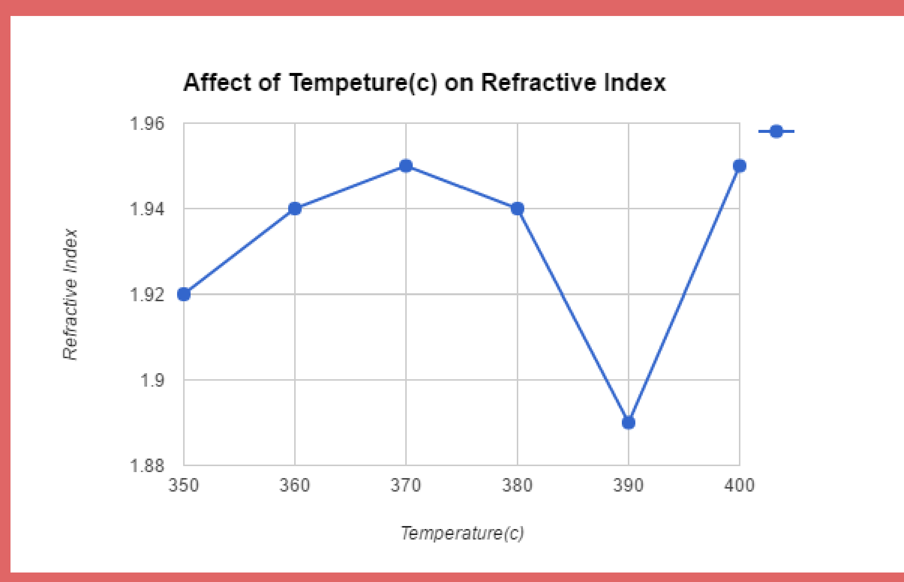
Results

Temperature

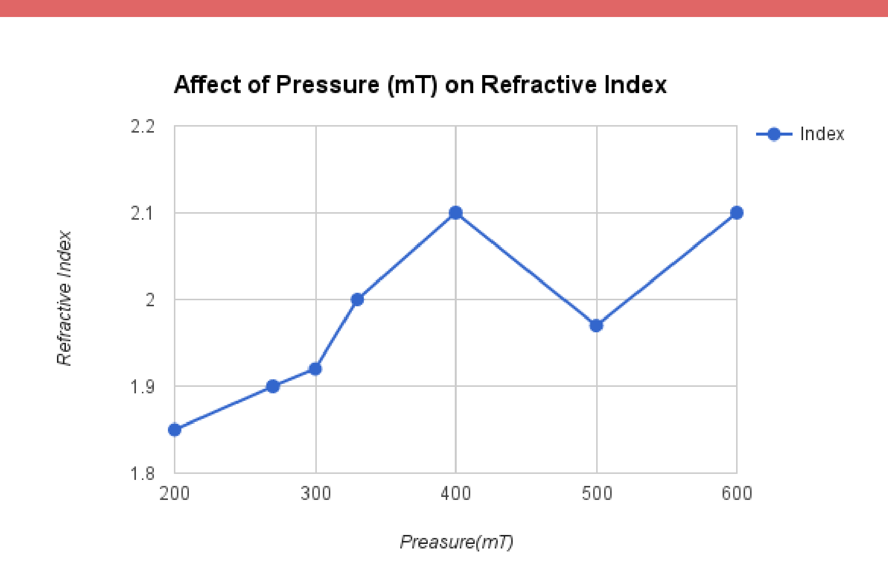


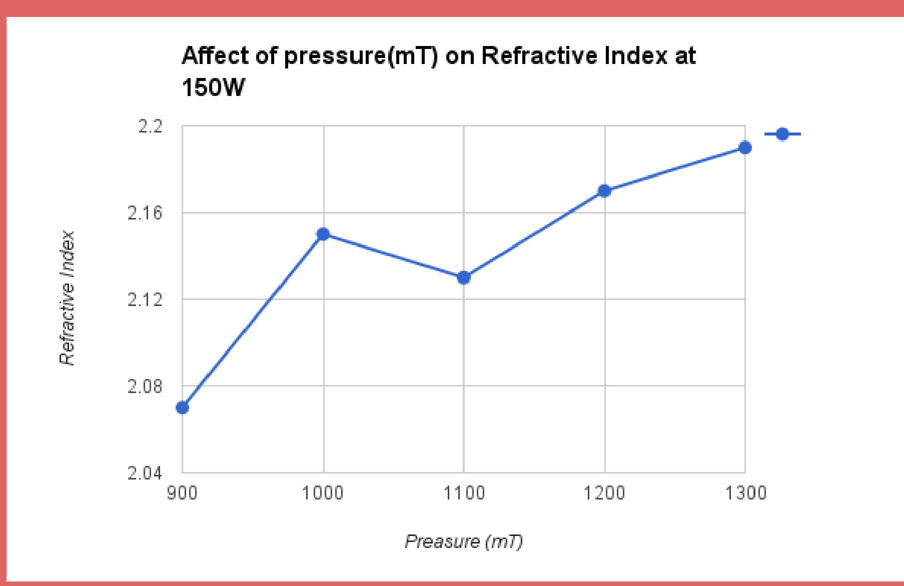


Temperature had little affect on index, thickness, or uniformity.

Wafers were very nonuniform making them hard to measure on the ellipsometer.

Preasure





Pressure had a small affect on index, but no effect on uniformity

Power

Effects of Power and Pressure on Index				
	Power(W)			
Preasure(mT)		50W	100W	150W
	300	1.92	1.97	2.08
	600	2.1	2.13	2.16

An increase in power does increase index. When we increase the power to 250W we also saw a large increase in uniformity.

Ratio and amount of SiH_4 and CH_4

Effects of amount and ratio of gases on Index						
	Ratio of gas					
Amount of gas		1/4	1/5	1/7	1/8	1/10
	5 sccm of SiH_4	-----	2.1	2.12	-----	2.14
	7.5 sccm of SiH_4	2.23	2.12	2.25	2.25	----

Stress

Effects of amount and ratio of gases on Stress (MPa)						
	Ratio of gas					
Amount of gas		1/4	1/5	1/7	1/8	1/10
	5 sccm of SiH4	------	-586	-486	-----	intensity below check limit
	7.5 sccm of SiH4	Wafer broken before properly measured	-371.4	-603.6	-421.1	----

Etch Test

The etch test was run with a 1:10 ratio of HF to water each piece was left in the solution for a minute and then cleaned and measured

The was a general trend of the SiC not etching

	Before	After
20	3054	3107
21	2740	3216
22	3275	2896
23	3532	2673
24	3279	3183
25	3321	3332

FTIR

Oxfordpecvd4 SiC
350C, 1400mT, 250W
60sccm CH4, 7.5sccm SiH4

Si-H

C-H

Si-C TO(Γ)

Si-C LO(Γ)

cm-1 1200 1100 1000 900 800 700 600 500

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Conclusion

Final Recipe

- 30 min deposition time
- 350 degrees Celsius
- 1400mT pressure
- 250 W of power
- 60 sccm of CH_4
- 7.5 sccm of SiH_4

Changes in Results 🎯

Index: Before 1.93, After 2.252
Thickness: Before 5285, After 3197
Uniformity:Before 28.7%, After 2.2%
Stress: Before -337.6, After -421.1
Etch: Didn't etch
Resmap: Didn't Conduct

Further Research Questions/Ideas

- More research on the effects of changing the ratios and amount of gases
- The association of color with index and/or thickness

Thank you to everyone who has helped me these last few weeks!!!!!!!!!