Determination of minority carrier lifetime and reflectance for textured and chemically polished Si wafers

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17 PUBLICATIONS **42** CITATIONS

Determination of minority carrier lifetime and reflectance for textured and chemically polished Si wafers

An internship with

बी एच ई एल
BHEL

Amorphous solar silicon cell plant, Gurgaon,
India, 122001

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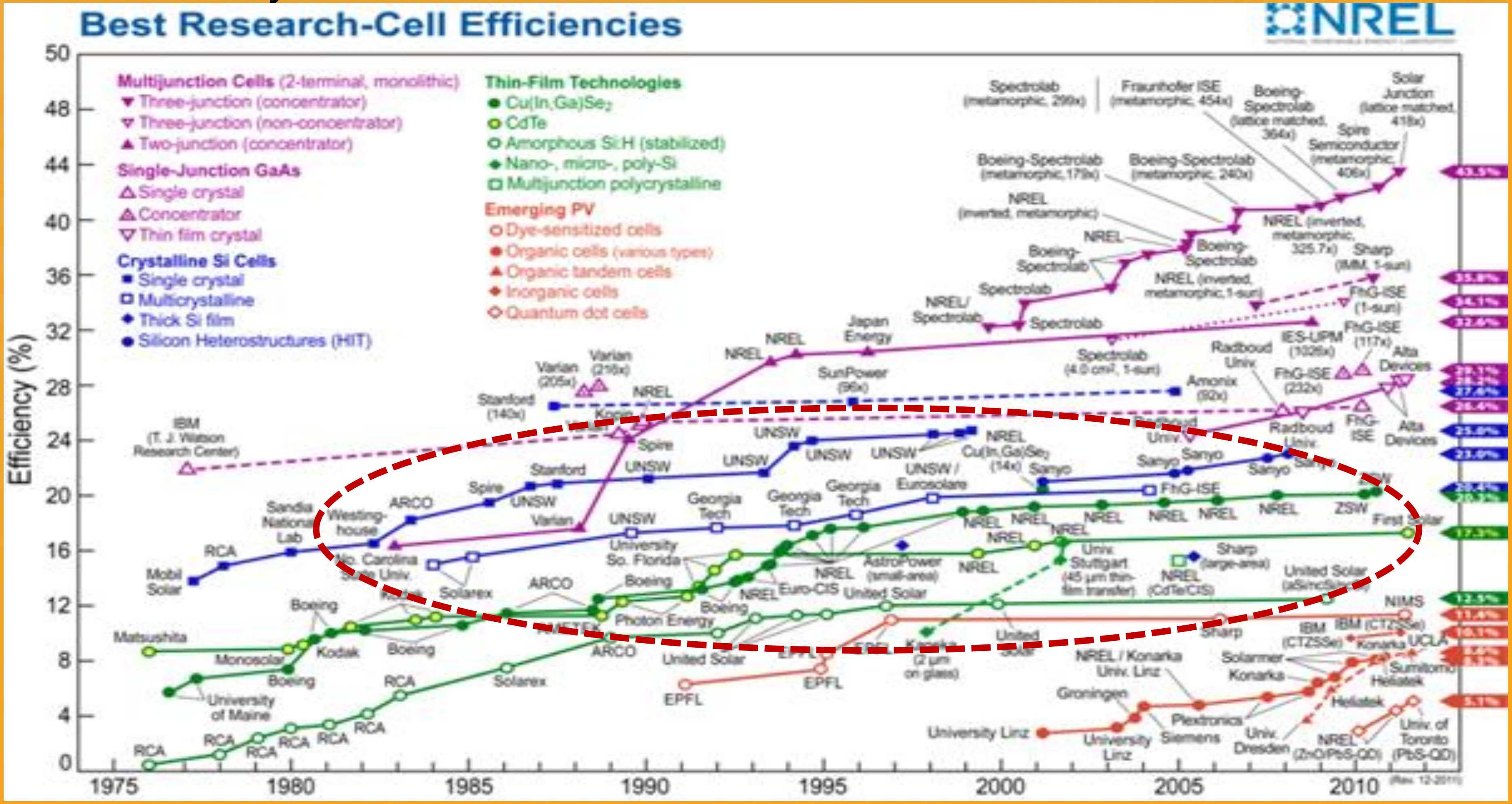
- Solar Cells (Photovoltaic)
- Hetrojunction/Amorphous/Monocrystalline/polycrystalline
- Reflection/Absorption
- Texturing and Polishing
- Minority carriers and carrier lifetime

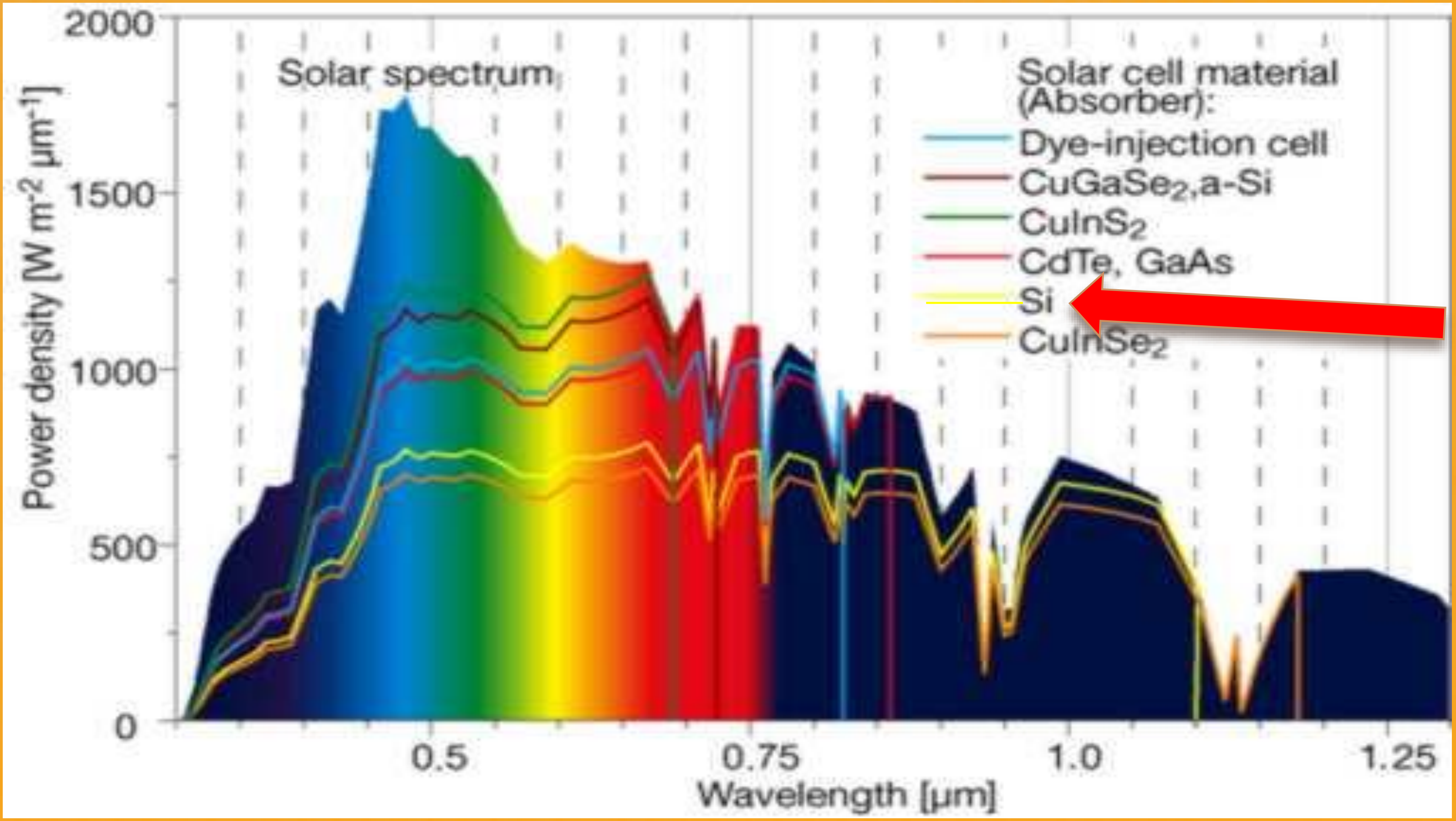


National Renewable Energy Laboratory, USA http://www.nrel.gov/solar/

Objective : To achieve high minority carrier life time

: To reduce reflection losses

: Optimizing Open circuit voltage and short circuit current such that fill factor is maximum



http://www.sunenergysite.eu

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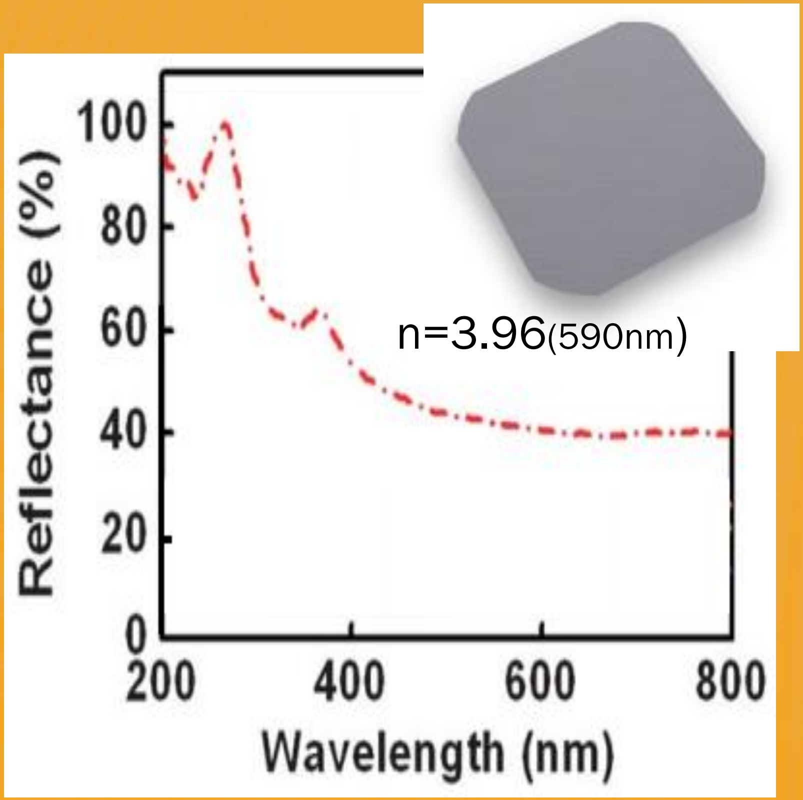

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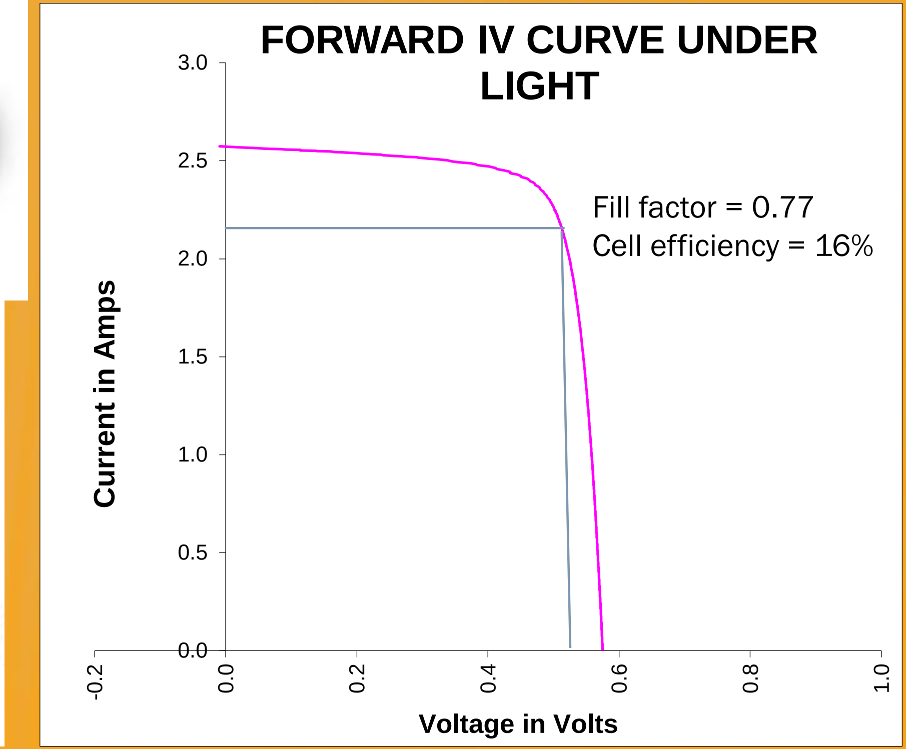
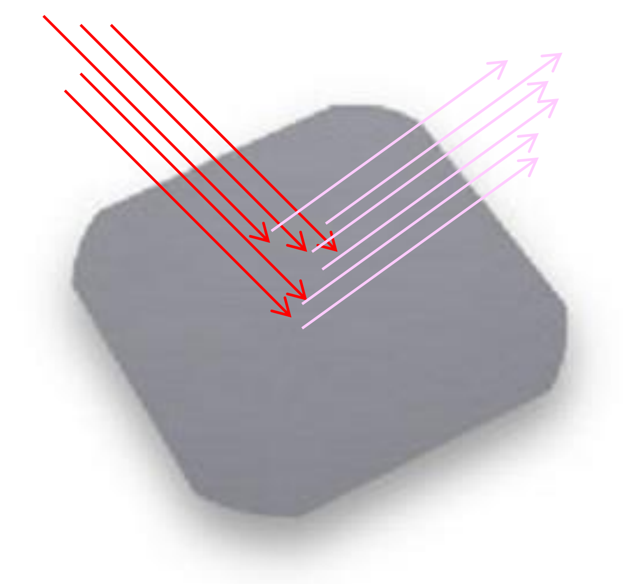
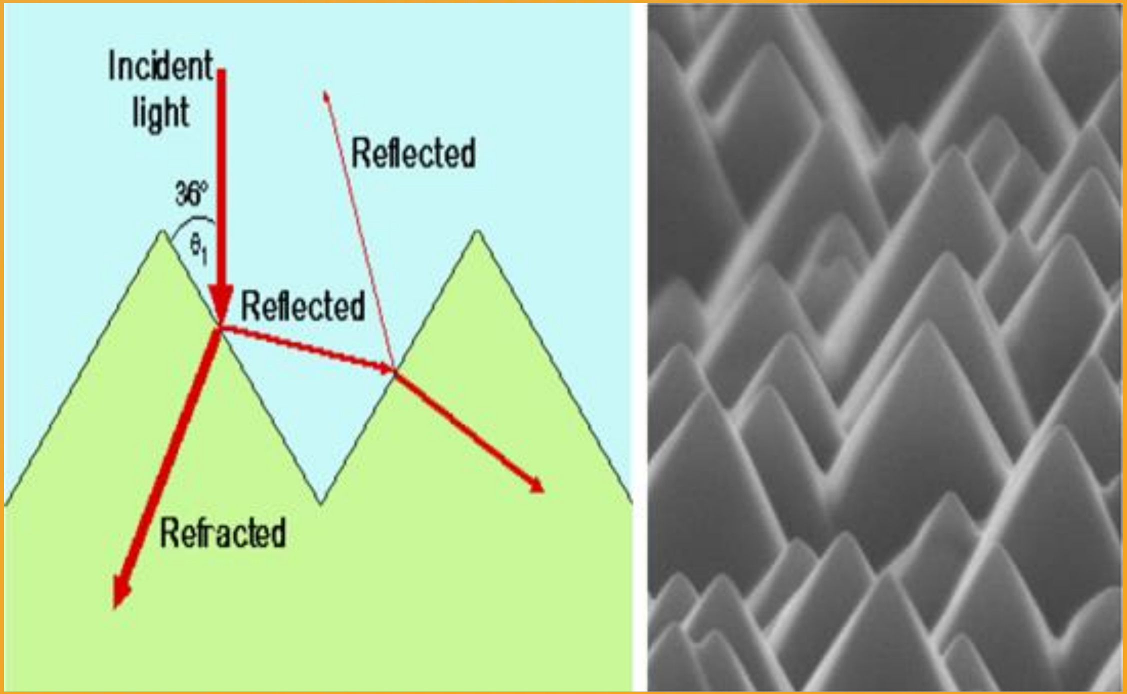


V-I characteristics for a monocrystalline (textured) silicon solar cell (cell area 250 cm2 ,avg temp 25°C, under light enabled)

Texturing : Increasing roughness to reduce reflection losses. There are several methods to texture silicon wafer surface such as Laser Texturization, Mechanical Texturization, Reactive Ion Etching, Anisotropic Wet Etching, etc. By using these methods we condition the wafer surface such that the reflection loss is minimal.



www.vacsol.com/en/products/materials/wafer



http://pveducation.org/pvcdrom/design/light-trapping

Experimental work

Texturing

Anisotropic wet etching (alkaline etching): Etching is slower in [111] direction as compared [100] and [110] ,which lead to formation of pyramid like structures on [100] type wafer (p-type) .

- **KOH + IPA** : Isopropyl alcohol along with 3% KOH solution and performed texturing for 16 min. → (Non uniform)
- **KOH + Additive** : 3% KOH solution + 30 ml additive. Additive (GP ALKA-TEX .+2) was used to increase boiling point of texturisation solution as well as it reduces the etch rate which in turn aids the peak formation and selective etching.

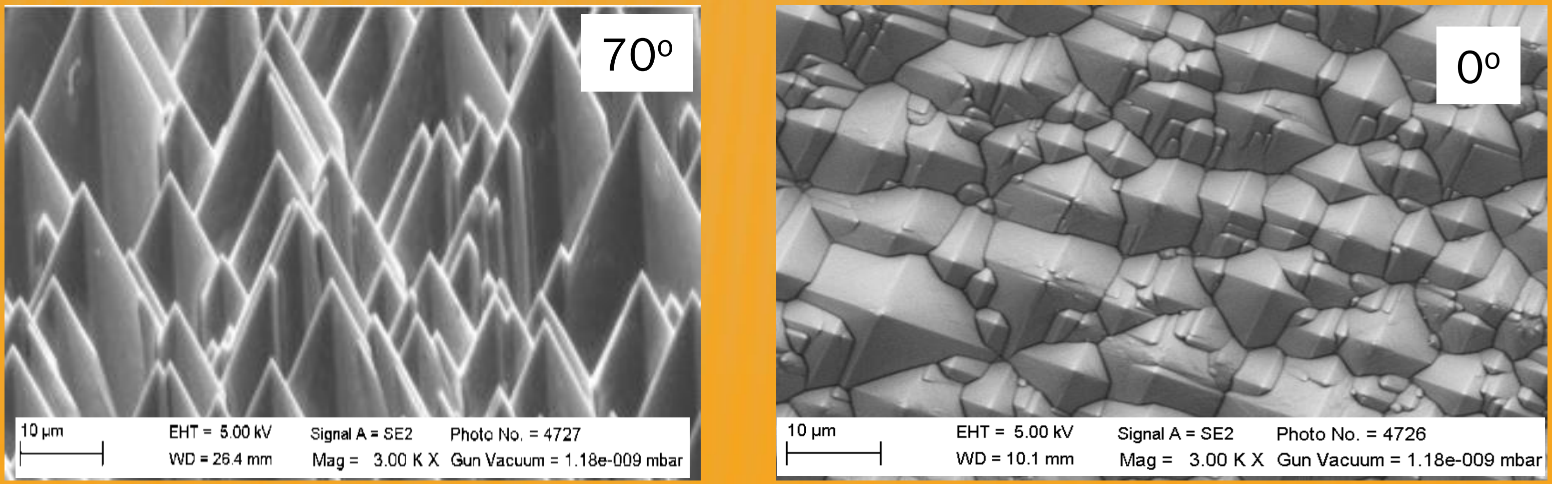


Fig : SEM images (Mag. 3K X) for textured wafer (IPA + 3% KOH) taken from the angle 70° and 0°

CHEMICAL POLISHING

Roundness of pyramids to increase Voc as well as minority carrier life. Though higher Voc can be achieved on a hetero junction solar cell without any surface texturing , but high reflectance/low current !!!!

HF (5%) /HNO3 : performed CP for 5,10,15 sec. at room temperature.

HF(10%)/HNO3 : performed CP for 5,10,15 sec. at room temperature.

HF/HNO3/CH3COOH : 1:6:3 ,CP for 5,10,15 sec. at room temperature.

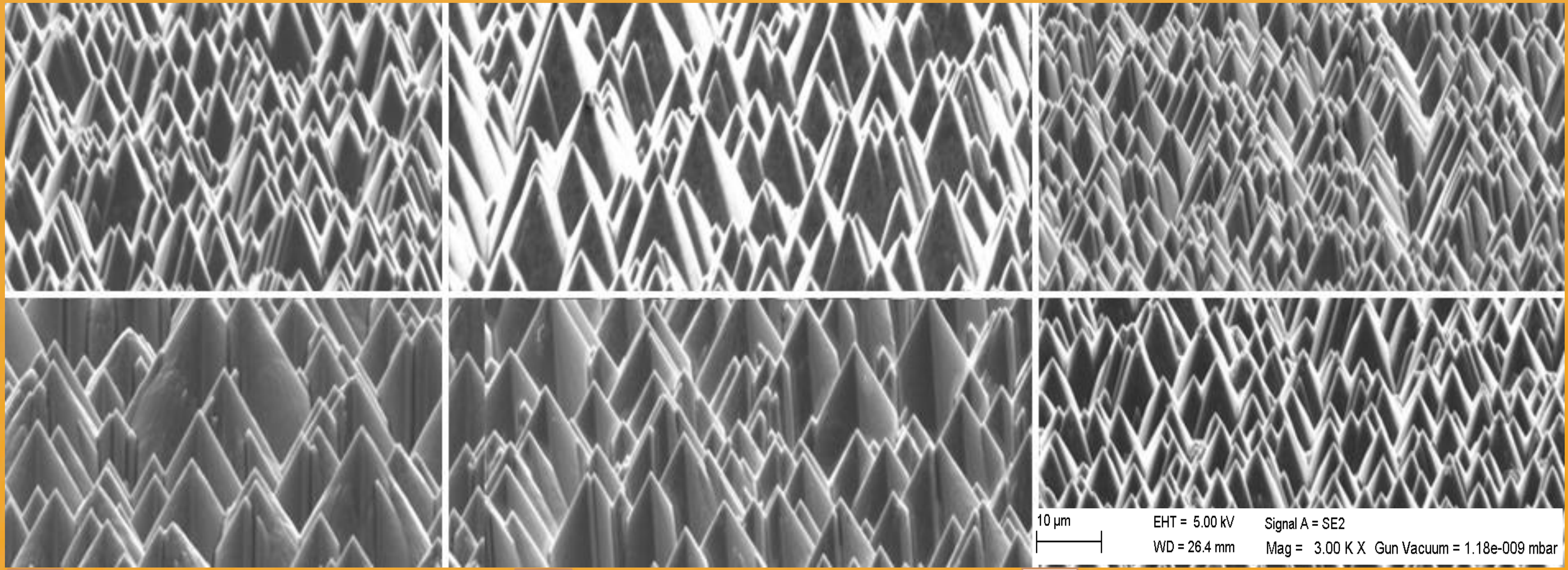
DI/HNO3/HF : 50 % concentrated HNO3-HF solution in DI. 5.75 litter DI 5 litter HNO3 and 0.75 litter HF and performed Polishing for 5,10,15 and 30 sec at low temperature 5 °C.

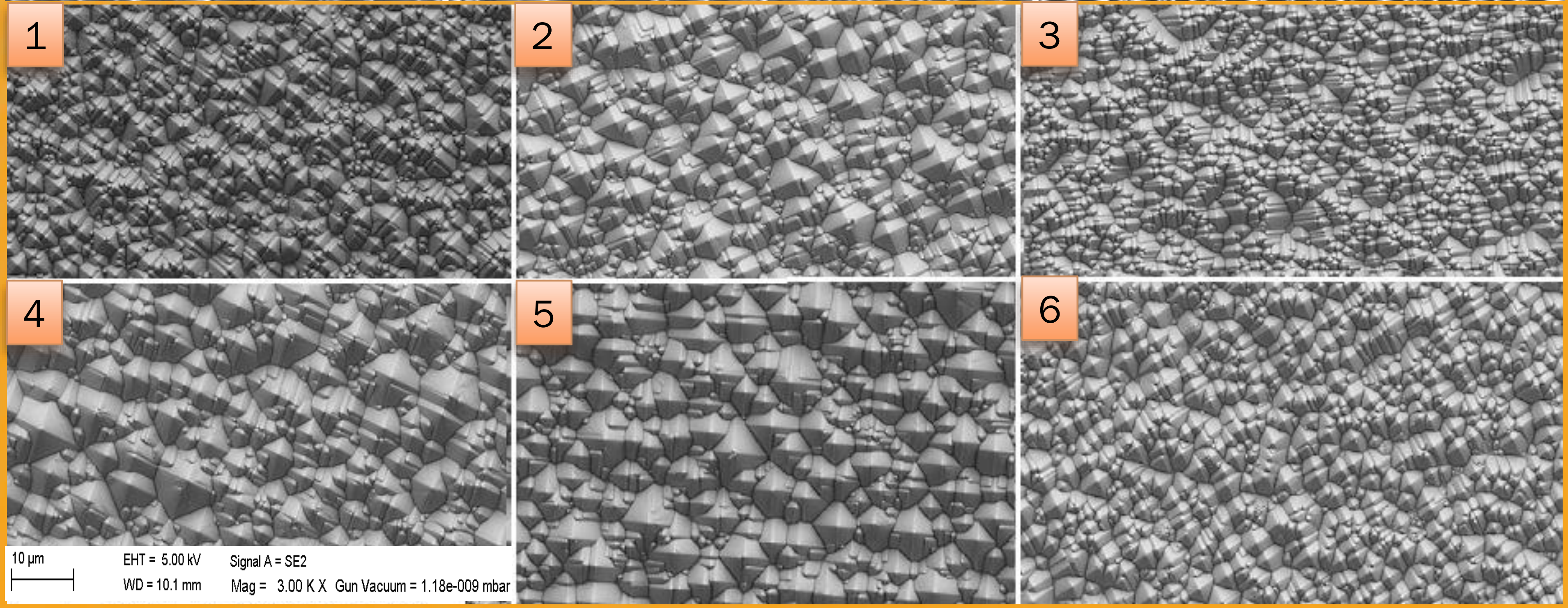
Results :

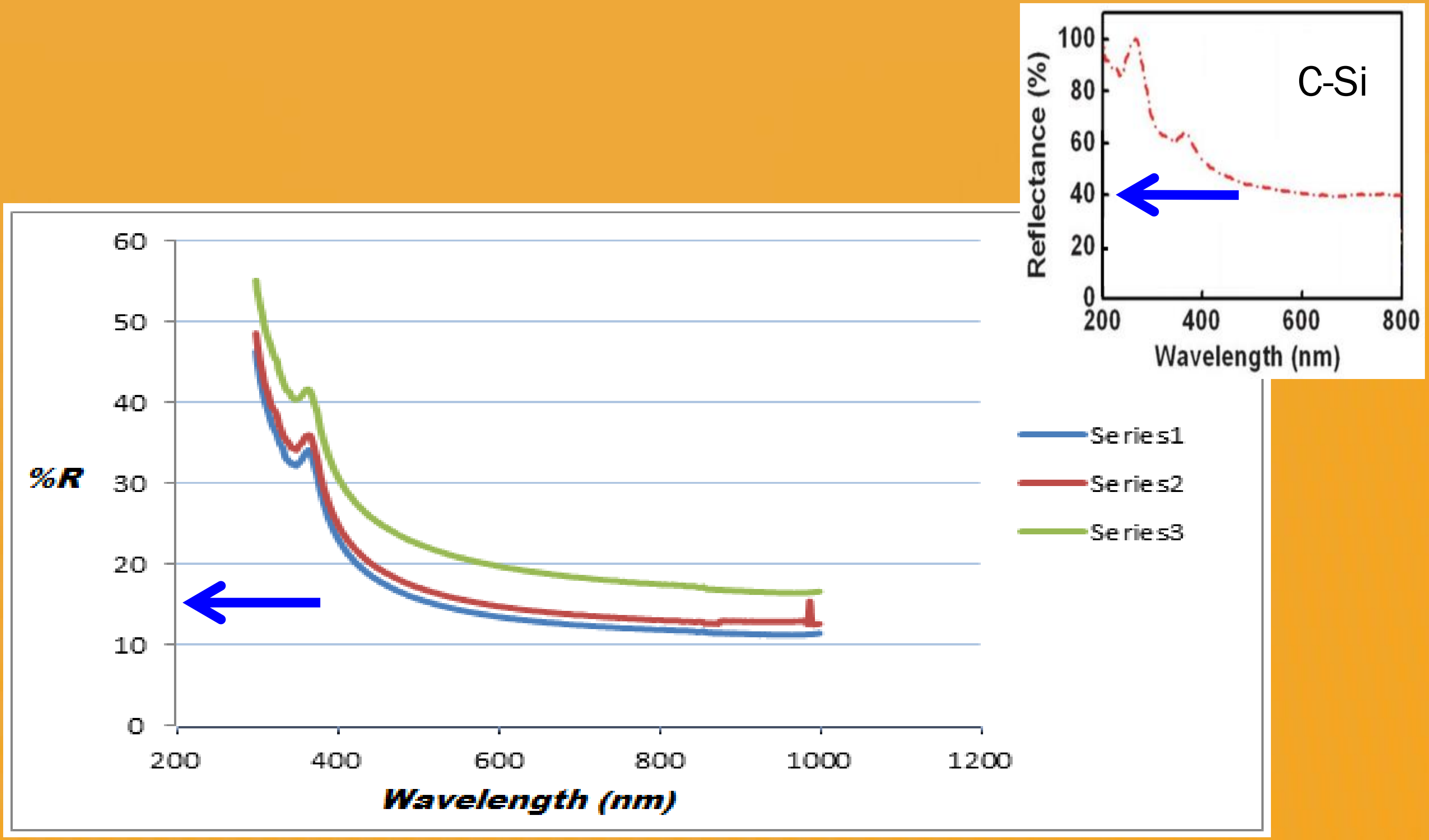
process	CP Temp (°C)	Process Time (Tex + CP)	Reflection (%) (650nm)	Minority carrier Lifetime (μS)
Non-Textured	-	-	-	83.1
Texturing		16 min + 0 sec	12.898501	65.3
Texturing	-	30min + 0 sec	12.68177	63.7
Texturing + CP (1)	30	16min + 10 sec		28.4
Texturing + CP (2)	30	16min + 5 sec	18.995174	26.2
Texturing + CP (3)	30	16min + 5 sec	13.099466	
Texturing + CP (4)	5	16min + 5 sec	14.183234	66.1
Texturing + CP (4)	5	16min + 10 sec	13.323968	69.3
Texturing + CP (4)	5	16min + 15 sec	12.229622	65.6

CP(1) = chemical polish by 5% HF/HNO3 Solution
CP(2)= chemical polish by 10% HF/HNO3 Solution
CP(3)= chemical polish by HF/HNO3/CH3COOH Solution
CP(4)=chemical polish by 50% diluted HF/HNO3 Solution

SEM images for the wafers 1.tex(16min) 2.tex(30min) 3.tex(16min)+CP1 (10sec) 4.tex(16min)+ CP2(5sec) 5.tex(16min)+CP3(5sec) 6.tex(16min)+CP4(5sec) are shown:


10 µm
EHT = 5.00 kV
WD = 26.4 mm
Signal A = SE2
Mag = 3.00 K X
Gun Vacuum = 1.18e-009 mbar


1
2
3
4
5
6
10 µm
EHT = 5.00 kV
WD = 10.1 mm
Signal A = SE2
Mag = 3.00 K X
Gun Vacuum = 1.18e-009 mbar



Reflectance measurement carried out by Spectrophotometer (Lambda 1050nm ,150mm sphere / downward view)

Series1 : textured 15min (3% KOH,RT)

Series2 : textured 15min (3% KOH , RT) +CP by 50% diluted HF/HNO3 (5 ° C)

Series3 : textured 15min (3% KOH , RT) +CP by 10% HF/HNO3 Solution

Thank you
for your attention !