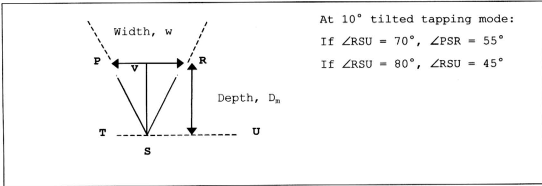
APPENDIX

Appendix A : Limitation of Depth Measurement by AFM



If ∠RSU = 70°, ∠PSR = 55°

$$\angle PSV = 35° \quad ...... (1)$$

$$\angle VSR = 20° ...... (2)$$

$$a \cos 20° = D_m ......(3)$$

$$b \cos 35° = D_m ......(4)$$

$$w = a \cos 70° + b \cos 55° ...... (5)$$

substitute (3) and (4) into (5) $w = D_m (\cos 70° / \cos 20°) + D_m (\cos 55° / \cos 35°)$

$$w = 1.064 D_m$$

$$\mathbf{D_m = 0.9398w ......(6)}$$

If ∠RSU = 80°, ∠PSR = 55°

$$\angle PSV = 35° \quad ...... (7)$$

$\angle VSR = 30° \ldots\ldots (8)$

$a \cos 20° = D_m \ldots\ldots (9)$

$b \cos 35° = D_m \ldots\ldots (10)$

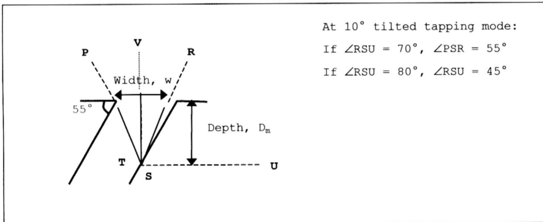
$w = a \cos 80° + b \cos 55° \ldots\ldots (11)$

substitute (9) and (10) into (11) $\quad w = D_m (\cos 80° / \cos 10°) + D_m (\cos 55° / \cos 35°)$

$w = 0.8765\, D_m$

$\mathbf{D_m = 1.1409w \ldots\ldots (12)}$

Equation (6) and (12) is valid for (111) wafer and only OISF that is slanted to the right for (100) wafer. Silicon tip movement blocked by the right wall of (100) OISF which was slanted to the left. Therefore difference ratio applied.



In this case (6) and (12) are $\quad D_m' = 0.9398w' \ldots\ldots (13)$ and

$D_m' = 1.1409w' \ldots\ldots (14)$ respectively.

If w = measured width of OISF

w' = width of the tip that can enter the OISF

D_m' = measured depth when tip movement is hindered by OISF right wall

For $\angle RSU = 70°$, $\angle PSR = 55°$,

$$w' = a \cos 70° + b \cos 55° \ldots\ldots (11)$$

$$w' = 1.064\, D_m$$

$$w = 2b \cos 55°$$

$$w = 1.4004 D_m$$

$$w' = 0.7598w$$

Therefore

$$\mathbf{D_m' = 0.7140w}$$

For $\angle RSU = 80°$, $\angle PSR = 55°$,

$$w' = a \cos 80° + b \cos 55° \ldots\ldots (11)$$

$$w' = 0.8765\, D_m$$

$$w = 2b \cos 55°$$

$$w = 1.4004 D_m$$

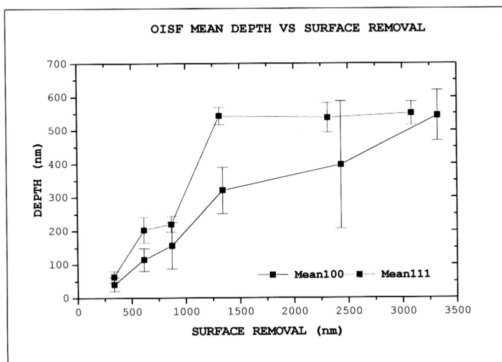
$$w = 0.6259w$$

Therefore

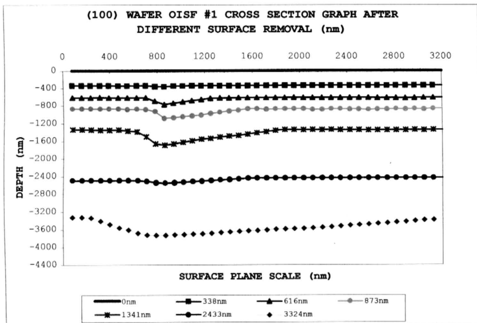
$$\mathbf{D_m' = 0.7140w}$$

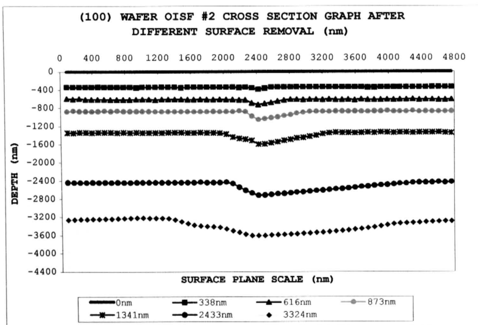
Appendix B : OISF Depth Measured by AFM

Figure below showed OISF depth on wafer surface after different surface removal in repeated preferential etching process. OISF depth for (111) wafers was found to increase faster than (100) wafer, at least for the first 3μm removed. (111) wafer showed an increasing trend in OISF depth but the depth saturated at 550nm after 1.25μm surface removal. However (100) wafers did not show this trend, a gradual increase in depth was observed as surface removal increases. OISF depth for these two types of wafers with different crystal orientation converged after 3μm surface removal.

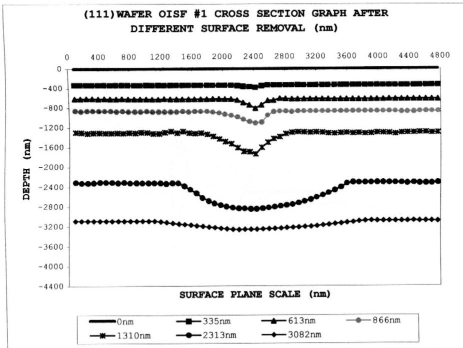


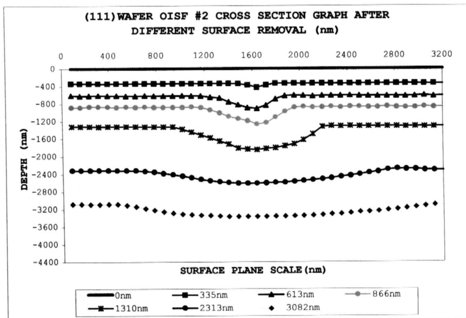
OISF depth with different surface removal for (100) and (111) wafers





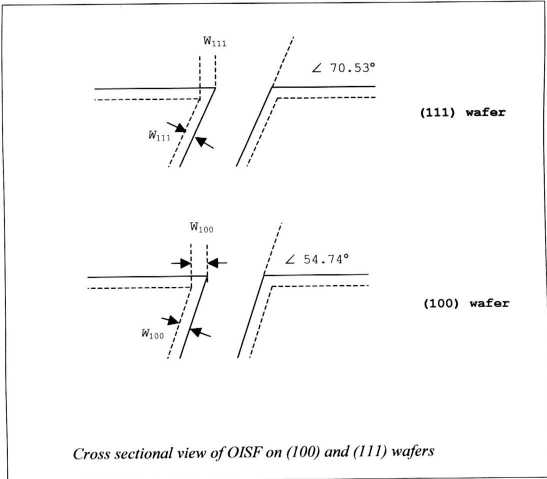
OISF cross sectional view on (100) wafer at different surface removal.





OISF cross sectional view on (111) wafer at different surface removal.

Appendix C : Explanation for the Comparable OISF Width for the (100) and (111) Planes.



Cross sectional view of OISF on (100) and (111) wafers

Since fault plane for (100) and (111) are both {111} planes, w_{100} and w_{111} would be the same if the wafers were etched under the same condition. For very small W_{100} studied, W_{100} would be comparable to W_{111}. Therefore the OISF width for (100) and (111) wafers are comparable for every surface removal.

$$W_{100} = W_{111}$$

$$W_{100} \, Sin\, 70.53° = W_{111} \, Sin\, 54.74°$$

$$\frac{W_{100}}{W_{111}} = \frac{Sin\, 54.74^{0}}{Sin\, 70.53^{0}}$$

$$\frac{W_{100}}{W_{111}} = 0.8661$$