HW 4  Pros 1

etch depth c

ideal IV

actual etched surface

\[ c = R_{100} t \]
\[ a = R_{111} t \]
\[ b = \frac{\sqrt{6}}{2} c \]

\[ \tan \theta = \frac{a}{b} = \frac{R_{111} t}{\frac{\sqrt{6}}{2} R_{100} t} \]

\[ \theta = \tan^{-1} \left( \frac{2}{\sqrt{6}} \frac{R_{111}}{R_{100}} \right) \]

\[ \phi = 54.74^\circ - \tan^{-1} \left( \frac{2}{\sqrt{6}} \frac{R_{111}}{R_{100}} \right) \approx 54.74^\circ - \left( \frac{60^\circ}{\text{rad}} \right) \frac{2}{\sqrt{6}} \frac{R_{111}}{R_{100}} \]

<table>
<thead>
<tr>
<th>( \frac{R_{111}}{R_{100}} )</th>
<th>( \phi )</th>
<th>to set 45°:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal</td>
<td>0</td>
<td>54.74°</td>
</tr>
<tr>
<td>EDP</td>
<td>\frac{1}{10}</td>
<td>52.29°</td>
</tr>
<tr>
<td>KOH</td>
<td>\frac{1}{400}</td>
<td>54.6°</td>
</tr>
<tr>
<td>1:1</td>
<td>\frac{1}{5}</td>
<td>45°</td>
</tr>
</tbody>
</table>

\[ \frac{R_{111}}{R_{100}} = \frac{54.74 - 45°}{60 \frac{2}{\sqrt{6}}} \]

← useful if you could do it repeatably
HW4 + prob 2

110 family intersections

\[
\begin{align*}
\{110 \cap 110 \cap 110 \} & \text{ perpendicular to } z\text{-plane} \\
110 \cdot 110 &= \sqrt{2} \sqrt{2} \cos \Theta_{110} \\
0 &= 2 \cos \Theta_{110} \\
\Theta_{110} &= 0 \\
-2 &= 110 \cdot 110 = \sqrt{2} \sqrt{2} \cos \Theta_{110} \\
\Theta_{110} &= \pm \pi \\
\end{align*}
\]

\[
\begin{align*}
110 \cdot 011 &= 1 = 2 \cos \Theta_{011} \\
\Theta_{011} &= \frac{\pi}{6} \\
110 \cdot 011 &= -1 = 2 \cos \Theta_{011} \\
\Theta_{011} &= \frac{3\pi}{6} \\
\end{align*}
\]
Goal: 50, 100, 200 μm deep trenches

Soln: Use 3 masks and STS/DRIE etcher.

But need to do all lithographically first
since we cant spin resist onto a wafer of
deep trenches.

E.g.: thermal oxide / TSO

Si₃N₄ LPCVD / T100

PR / T200

DRIE 100 μm
Strip PR

DRIE 50 μm
Etch nitride in hot phosphoric

DRIE 50 μm

⇒ The oxide mask defines all of the trenched
and the nitride and PR masks block them
at different times.

Alternate masks: oxide, aluminum, PR
aluminum, polyimide, PR
thermal oxide, PSG, PR

Le need a timed HF etch to strip
PR and not thermal ox.
Not too hard, since etch rates
ciffer by 25X
HW 4 #4

Goal: 400µm deep ~ hemispherical cavities
50 µm deep square trenches.

Soln 1: LPCVD nitride/HEMISHOLE + TRENCH
LPCVD PSG / TRENCH-COVER
XeF₂ timed etch 400µm (or other isotropic etchant)
strip PSG
STS DRIE 50µm

Soln 2: maybe can etch trenches first, then spin resist
to mask XeF₂. Trenches will create
streaks & lumps in PR, making exposure/develop
difficult, but since the trenches can be 400µm
from the XeF₂ etch hole, it might work.

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[Diagram of trench and etch hole]