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<td><strong>Author(s)</strong></td>
<td>Tay, Stephen En Rong</td>
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Stress Studies on Ti and TiN Interlayer in (100) Silicon Wafers

Introduction
- Ti is used to improve wettability between Al and Si.
- TiN is used as a diffusion barrier to prevent diffusion of Al into Si during annealing.
- In this study, stress from Ti and TiN thin-films on (100) Silicon wafers are studied using Stoney’s equation.

Theory
- Stoney’s equation is used to measure stress from thin-films\(^1\) and can be represented by Stoney’s equation\(^2\):
  \[
  \sigma = \frac{E}{1-v} \cdot \frac{1}{6} \cdot \frac{t_s^2}{t_f} \cdot \frac{1}{R}
  \]
  - Where \(\sigma\)=stress, \(E/(1-v)\)=biaxial modulus of the substrate, \(t_s\)=substrate thickness, \(t_f\)=film thickness and \(R\)=radius of curvature.

  \(R>0\) \(\rightarrow\) Bow>0
  \(R<0\) \(\rightarrow\) Bow<0

  - This occurs due to lattice mismatch and differences in coefficient of thermal expansion of the materials\(^3\).

Experimental setup
1. Three wafers were chemically cleaned by RCA standards.
2. Bow and radius curvature were measured before deposition.
3. Si/Al(1um) was deposited at 50°C, Si/Ti(100nm)/Al(1um) at 50°C and Si/TiN(100nm)/Al(1um) at 375°C.
4. Bow and curvature were measured after deposition.

Experimental results
- Stress from different films

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Discussion

<table>
<thead>
<tr>
<th>CTE (um/m°C(^4))</th>
<th>Si</th>
<th>Al</th>
<th>Ti</th>
<th>TiN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalized CTE wrt Si</td>
<td>1.0</td>
<td>9.6</td>
<td>3.6</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Stress arise due to different coefficient of thermal expansion. Deposition was done in a heated environment. When wafers were taken out, the films cooled at different rates from silicon which resulted in stress.
- Stress in TiN/Al is high due to high deposition temperature of 375°C.
- Before deposition of films, all three wafers showed some curvature. This could be due to uneven polishing of the wafers from the manufacturer side.
- Future directions could include thermal loading cycles.

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References
3. Gad-el-Hak, Mohamed, MEMS: Design and Fabrication, CRC/Taylor & Francis, 2006