Thermal Annealing of Low Dosages Chromium and Vanadium Ions Implanted into (100) Silicon

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It is well known that transition metal impurities in silicon can strongly influence the electronic properties of silicon¹. They have a deleterious effect on yield, reliability and performance. Thus the understanding of unintentional metal impurity contamination of silicon wafers is of great importance and the transition metal impurities in silicon have been intensely studied in the past decades²,³.

Recently, diffusion profiles of Chromium and Vanadium with dosages ranging from $10^{12}$ to $10^{15}$ cm$^{-2}$ have been studied⁴ in our laboratory at temperatures from 300°C to 1000°C. The high dosage results⁵ can be explained by the amorphization of the silicon substrate and the subsequent solid phase epitaxial growth of the amorphous layer. However, at low dosage, the diffusion profiles are very complex indicating a peculiar behavior as shown in Figure 1.

In order to better understand the complexity of this behavior, the diffusion profiles of Cr and V at low dosages $1.0 \times 10^{12}$ cm$^{-2}$ and $1.0 \times 10^{13}$ cm$^{-2}$ were carried out for different intervals at temperatures 450°C and 550°C as shown in Figures 2 and 3.

The redistribution of impurity profiles are characterized by Secondary Ion Mass Spectrometry (SIMS). The results are compared with previous measurements⁶ at high dosages. We found that the diffusion profiles of Cr and V implanted into silicon are strongly depended on the dosages; the diffusivity of some low dosages V and Cr into silicon was calculated in table-I. The interaction between the impurity ions and defects caused by ion implantation will be discussed.

REFERENCES


Table I. Diffusivities of the V and Cr elements into silicon

<table>
<thead>
<tr>
<th>Element</th>
<th>Concentration</th>
<th>Time</th>
<th>Temp.</th>
<th>D(cm²/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>1E12</td>
<td>1 hr</td>
<td>550 °C</td>
<td>1.1x10⁻¹⁴</td>
</tr>
<tr>
<td>Cr</td>
<td>1E12</td>
<td>4 hr</td>
<td>450 °C</td>
<td>8.3x10⁻¹⁶</td>
</tr>
</tbody>
</table>