IMPROVEMENT IN THE SIMS MEASUREMENT OF BULK NITROGEN IN SILICON
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In 1988 the successful SIMS measurement of nitrogen in nitrogen-doped Cz-Si was first reported [1]. The typical background nitrogen levels were about 5x10^{13}/cm^{2}, so the detection limit was on the order of 2 to 3 times the background level, or 1-2x10^{12}/cm^{2}. In the late 1990's there was a resurgent interest in N-doping of Cz-Si at levels of 10^{13}-10^{14}/cm^{2}. The ability to measure N in bulk silicon became important again but at levels often below the detection limit of SIMS. A re-evaluation of the SIMS measurement was reported in 2000 [2]. The background level was reduced to about 1x10^{12}/cm^{2}, thus improving the detection limit by 5x, but still leaving an important range of nitrogen doping outside the range of detection by SIMS. Furthermore, the varying background level during a measurement posed a problem for measurement precision.

A key improvement in the measurement occurred as a result of a collaboration between a JEITA Working Group and an ASTM Task Force whereby a raster change technique, originally developed for measuring oxygen in silicon [3], was introduced to the nitrogen measurement. This technique not only resolves the varying background problem, but also greatly improves the statistics for the background subtraction [4]. A final test method was issued under ASTM F 2139-01. [5].

At Charles Evans & Associates we have achieved the following long term precisions (one relative standard deviation, RSD) using the ASTM F 2139 test method.

<table>
<thead>
<tr>
<th>Doping Level</th>
<th>Long Term Precision (RSD)</th>
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<tbody>
<tr>
<td>1.7x10^{13}/cm^{2}</td>
<td>7%</td>
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<tr>
<td>7.3x10^{12}/cm^{2}</td>
<td>19%</td>
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<tr>
<td>4.1x10^{12}/cm^{2}</td>
<td>26%</td>
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