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APPLICATION NOTE

SIMS Measurement of Bulk [N] in Nitrogen-doped Cz-Si: Long Term Precision Results

DISCUSSION

Advanced silicon substrate products are being developed for the 90 nm node and smaller devices of the future. Nitrogen-doping during Cz-Si crystal growth is a key technology for some of these products, because this facilitates the engineering of defect properties needed for the low temperature processing at 90 nm node and smaller devices. The measurement of bulk [N] is required at the 10^{13}-10^{14}/cm^3 range for these advanced silicon substrate products.

The goal of the industry is to develop an FTIR measurement of the bulk [N], but achieving this at the required concentration range and acceptable precision is still a challenge. An ASTM F 2139 test method for the SIMS measurement was approved in 2001, but the actual precision of the measurement needed improvement and the test method was applicable only down to 1x10^{14}/cm^3. At EAG Laboratories, we have improved the SIMS measurement precision using the ASTM F 2139 test method and extended the detection capability into the 1x10^{13}/cm^3 levels. Here we present long term (20 months) precision results for three levels of nitrogen in silicon. Table 1 shows the relative one standard deviation (RSD) for each level. Figure 1 shows the long term trend chart for nitrogen concentrations of 1.7x10^{14}/cm3, 7.3x10^{13}/cm^3, and 4.1x10^{13}/cm^3. These results show the excellent capability of our SIMS to make this measurement which can be used to calibrate reference materials for FTIR research and development, and to monitor crystal growth processes until the FTIR measurement development is successful.

Sample	Average [N]	RSD
X	1.7x10^{14}/cm^3	7%
Y	7.3x10^{13}/cm^3	19%
Z	4.1x10^{13}/cm^3	26%

Table 1: Long term RSDs for three levels of [N]

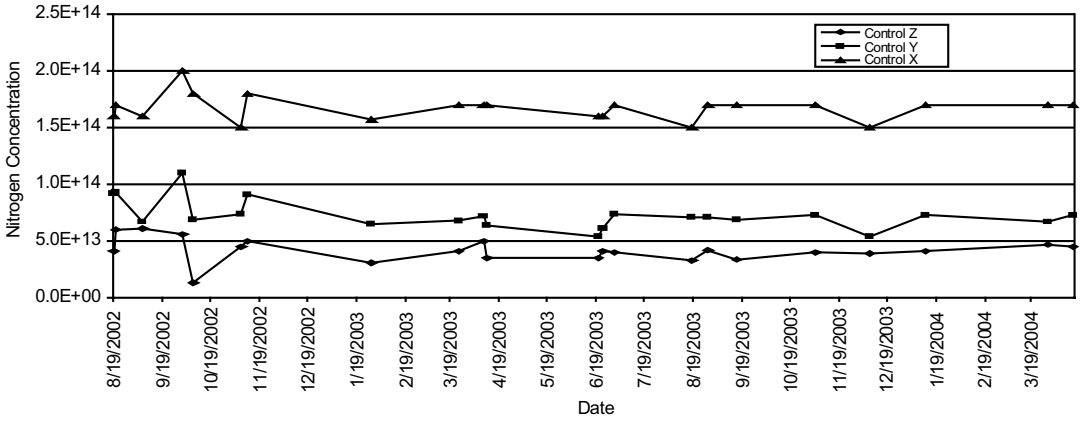

Figure 1: Long term (20 months) repeat measurements for Samples X, Y and Z.

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