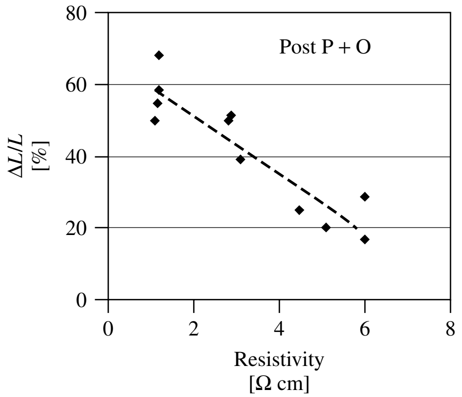

Figure 6.5 Relative degradation of diffusion length versus base resistivity for tri-crystalline silicon, measured after a standard P-diffusion and oxidation process

to be accomplished, a strong correlation of the effect with boron and oxygen is well established. Because tri-Si is grown with boron doping using standard Cz technology, an impact of LID on electrical quality is also present. Figure 6.5 shows a plot of the relative degradation as a function of base resistivity after a standard P-diffusion and oxidation process. Relative degradation values of less than 30% can be reached with 4- to 6-Ωcm material.

Tests on Si crystals fabricated from virgin poly-feedstock material with gallium, indium or aluminium as doping material have been performed to study LID. Best results have been obtained for Indium-doped material, for which the LID effect is reduced to almost below 3% of the diffusion length, which is within the accuracy limit of the ELYMAT measurements. With this material, light stable diffusion length values above 1 mm (!) can be achieved. This material is therefore best suited for high-efficiency cell processes.

In order to test the tri-Si material with standard solar cell processes, test cells are manufactured with a modified "Siemens Solar Boron Back Surface Field" (BSF) process with screen-printed contacts, as described in [12]. The final cell thickness was between 120 and 250 μm. A boron-BSF process was chosen since the BSF is crucial for high efficiency at reduced wafer thickness and beneficial for material with high diffusion length. SiN deposited with a commercial low pressure chemical vapour deposition (LP-CVD) method was applied as an AR coating, that is, no volume passivation can be expected since no molecular hydrogen was present during SiN deposition. In this case no complicated passivation or activation effects of hydrogen in Si must be taken into account [13–16]. In order to eliminate the effect of the different surface orientations and in order to focus on the pure material response, the wafers were *not* textured.

Table 6.1 shows that the efficiencies reach 15.5% in a lab-scale average. This efficiency compares well and slightly exceeds the results of corresponding solar cells from *solar-grade* <100> mono-material that was grown in standard production. The champion tri-Si cell efficiency without surface texturing was 15.9% using this cost-effective process.