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LATTICE TEMPERATURE OF GaAs AND Si DURING PULSED LASER ANNEALING

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Abstract - Both GaAs (100) and Si (110) single crystals were laser annealed with a 20 ns ruby laser pulse. By means of a time-of-flight measurement the velocity distribution and the density variation of evaporated Ga or As and Si atoms were determined for different energy densities. Simultaneously the reflectivity of the crystal surface was measured time-resolved. The data show consistently that the molten phase with high reflectivity occurs at energy densities $\approx 0.35 \text{ J cm}^{-2}$ for GaAs and $\approx 0.8 \text{ J cm}^{-2}$ for Si. The results confirm a purely thermal model for laser annealing of semiconductors. In the case of GaAs the influence of the latent heat during melting could be clearly resolved.

Since this paper has been published recently /1/, only the main figure is shown, where the lattice temperature $T$ as derived from the time of flight measurement is plotted versus energy density of the laser pulse. $T$ increases steeply up to 0.3 J/cm$^2$ until it reaches about the normal melting temperature of GaAs. Then the temperature remains at this value (within the scatter of the data) because the latent heat of fusion has to be put into the GaAs. Only for energy densities above 0.5 J/cm$^2$ the temperature of the liquid phase increases again.

Fig. 1: Temperature of emitted Ga and As atoms versus energy density of the 20 ns Ruby laser pulse. Three typical error bars are shown.

The occasional (shaded region) or permanent (solid line) occurrence of the high reflectivity, i.e. liquid phase is indicated above the abscissa.

Reference