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Experiments on Silicon Magnetodiodes.

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Double injection p-i-n diodes have been fabricated by the lithium drift process. The magnetosensitivity of the device depends on the difference in the recombination velocities of the two surfaces perpendicular to the Lorentz force. Because it is not difficult to obtain strong surface recombination, the crucial technological problem is to prepare a silicon p-i-n diode with at least one relatively slowly recombining surface. The problem was attacked by thermally growing an oxide layer. The lithium drift process has to be carried out after the oxide is grown because of the different temperatures of these two fabrication steps (lithium drift at 100°C and thermal oxidation at 1100°C). The resulting surface recombination was low enough (about 100 cm/sec) to yield remarkable positive and negative magnetoresistance effects. This behaviour is well known from germanium diodes [1] but to our knowledge was never reported for silicon diodes before. Static current-voltage characteristics as well as the current build-up after the application of some diode voltage (turn-on) have been measured at room temperatures for electric drift fields up to 500 V/cm and magnetic fields up to 20 kG. On the basis of a recently developed theoretical model [2], which combines double injection and galvanomagnetic recombination, the time dependent characteristics were analyzed. Current turn-on occurs in two steps: an ohmic current corresponding to the intrinsic concentration appears at once while the final current builds up according to an exponential time law. The characteristic risetime represents a generalization of Shockley's filament lifetime. The magnetic field dependence of the risetime indicates a kinetic magnetodiode effect supplementing the stationary effect. From comparison between theory and experiment the bulk lifetime and the surface recombination velocities were determined. An additional field-effect electrode above the oxide was used to influence the space charge beneath the surface as well as the surface recombination behaviour and thus the diode characteristics.

(1) T. Yamada, Proc. Int. Conf. on the Physics of Semiconductors, Moscow 1968, p. 672
(2) H. Pfleiderer, submitted to Solid State Electronics.