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Theory and experiment for silicon Schottky barrier diodes at high current density

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Abstract

Metal-silicon Schottky barrier diodes exhibit *n* values which theoretically vary as a function of doping and applied voltage. The expected variation depends on which theoretical model is used to describe the current transport.

Titanium *n*-type silicon barriers were prepared. At a doping level of 3×10^{15} cm^{-3} the barrier height and *n*-value measured at 100 mV were 0.485±0.005 V and 1.02±0.01 whereas for a doping level of 2×10^{14} cm^{-3} the corresponding values were 0.500±0.005 V and 1.18±0.05.

The experimental variation of the diode *n* value as a function of semiconductor band bending showed good agreement with the thermionic-diffusion model of Crowell and Beguwala: *n* values increased rapidly as the band bending $\beta \to 2$, and *n* values were highest at a given β for diodes with the lowest doping concentration. Similar results were obtained by measurements on magnesium and aluminium barriers on *n*-type silicon.

An analysis of the results has shown that the variation of the diode saturation current I_s follows the predictions of the thermionic-diffusion theory, although there were some anomalies at high current densities. The anomalies did not result from variation of the width of the undepleted region of the epitaxial silicon layer or from diode self-heating effects.