

Self-monitoring of breakdown in integrated semiconductor devices

Background

Fast integrated circuits are known to have an early breakdown at p-n junctions. The breakdown occurs above a critical field strength and leads to the destruction of the integrated circuit. Therefore, to avoid destruction, the device is only able to be operated in a very limited operating range.

Problem

To date, breakdowns can only be prevented by external voltage or current control. When taking into account individual variations of devices and the effect of changes in temperature, the current approach severely limits the operating range. This restriction results in a greatly reduced performance.

Solution

The breakdown monitoring which is the object of this invention is achieved in real time by means of a photo diode which is integrated in the semiconductor device. During a breakdown, a p-n junction always emits light. It is this light emission that is recorded by the photo diode which is integrated in close proximity of the junction. In response to the strength of the light emission, one can then adjust the voltage or current that is applied to, resp. passes through the junction. When the light emission by the p-n junction increases above a certain value, the voltage (or current) across the junction is reduced until the light emission is below the critical threshold. By this means, a complete breakdown can be prevented while allowing operation over an extended range. The regulation mechanism can also be integrated into the semiconductor element. It is further possible to monitor several p-n junctions within an integrated circuit by means of several photodiodes. This invention allows the operation of an element, for example a transistor, at a level just below breakdown or even at the breakdown level without risking destruction. This monitoring and regulatory arrangement allows the operating range to be broadened and increases the performance without the risk of the junction being destroyed.

Contact

Dipl.-Ing. Emmerich Somlo
TLB GmbH
Ettlinger Straße 25
76137 Karlsruhe | Germany
Phone +49 721-79004-0
somlo@tlb.de | www.tlb.de

Development Status

Concept / TRL2

Patent Situation

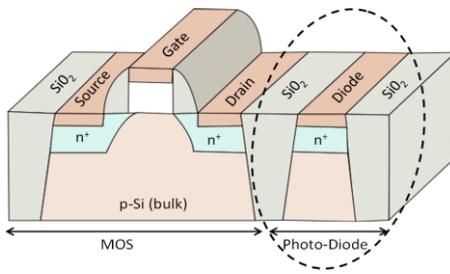
DE 102007002820 B3 granted
EP 2126972 B1 granted,
GB, FR validated
US 8,519,732 B2 granted

Reference ID

057/06TLB

Service

The Technologie-Lizenz-Büro GmbH has been charged with the commercialization and now offers companies the opportunity to obtain a license to exploit this new technology.



Semiconductor device with integrated diode.

Advantages

- Increased power of transistors, e.g. in oscillator circuits (radar, etc.) because of the possibility of operating the transistors at the breakdown point
- Increased reliability of ICs through the ability to monitor weak points continuously and respond with appropriate regulatory interventions
- Increased operating range and increased power of semiconductor elements and integrated circuits
- Increased temperature range
- Increased capacity to deal with variability in device characteristics
- Protection from destruction and consequent failure to perform

Application

Breakdown monitoring for integrated circuits.