RGHCI

PRODUCT BRIEF

Ridgetop Group Inc

ENGINEERING INNOVATION

Hot Carrier (HC) Measurements with Sentinel Network™ for Burn-in Optimization

Electronic Prognostics

Industry-Standard, High-Performance, Electronic Prognostic Technology

- Acts as an early-warning "sentinel" of upcoming degradation of MOS transistors caused by high-energy electron injection into the gate oxide. Damage occurs in the form of localized charge trapping, which causes a decrease in drain current ID and an increase in threshold voltage (V_T).
- Inspects drain avalanche hot carrier (DAHC) injection and channel hot electron (CHE) injection
- Approx. 600 mW power
- 500 μm_2 footprint at 0.13 micron process
- Measures in present of delta V_T shift of 2, 4, 6, 8, and 10%

General Description

Promoting miniaturization without scaling the supply voltage implies increasing the electric field intensity of the internal elements of a device. This is especially true in the case of MOSFETs, where the electric field intensity near the drain area increases and a hot carrier degradation effect occurs.

Carriers (electrons) that flow into the high-electric-field area are accelerated by the strong field, and gain substantial energy. Some of the carriers become a hot carrier, which means they have enough energy to overcome the electric potential barrier existing between the Si substrate and gate oxide film. These degradations cause the deterioration of all semiconductor device characteristics and ultimately lead to failure.

The Ridgetop Hot Carrier (HC) Damage Prognostic Cell, shown in Figure 1, is a pad-limited CMOS hot carrier damage/failure detection cell. Its unique and proprietary architecture behaves as an early-warning "sentinel" of an upcoming hot carrier damage fault condition in the host circuit. The amount of pre-warning is given in the form of percent of delta V_T shift from 2 to 10%.

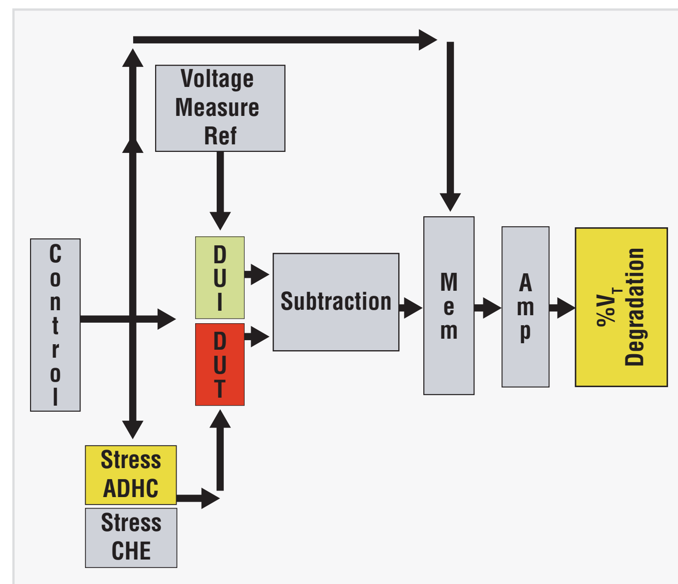

Figure 1: Hot Carrier Damage Prognostic Cell block diagram

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This pre-warning is shown in Figure 2, where the measurement of degradation includes all of the stresses that the host circuit sees, both internal and external. This data can then be used during the test and burn-in cycle of the chip.

Prognostic Distance

The prognostic distance (Figure 3) is adjusted by scaling the area of the cell. Ridgetop has nominally set this at 80% of the statistical end-of-life point. This point can be adjusted to some other early indication level. A "picket fence" can also be constructed with multiple cells evenly spaced over the bathtub curve. These cells would be looking at a different percentage of V_T shift.

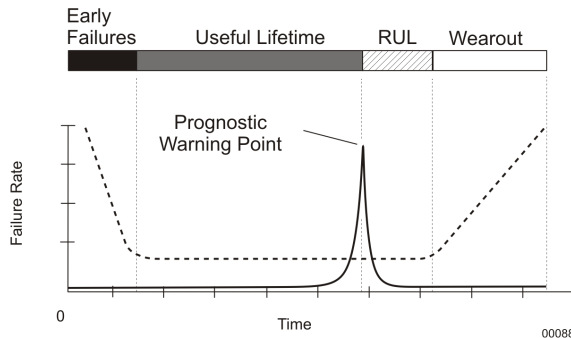

Figure 3: Bathtub curve showing prognostic distance

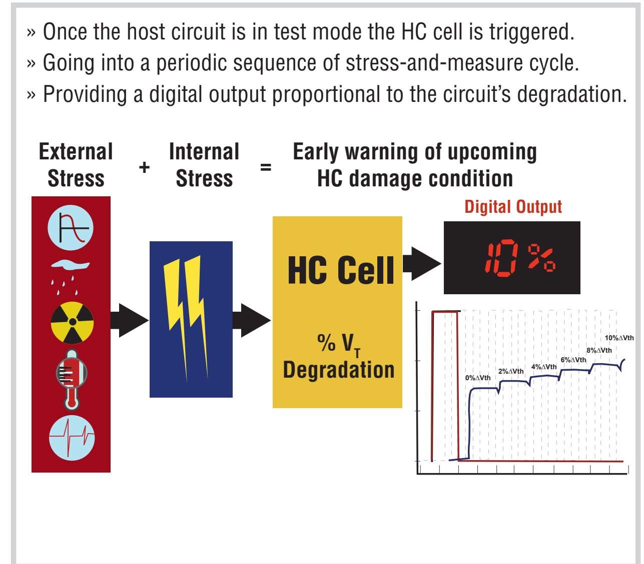

Figure 2: Stress-and-measure mode

Interfacing

The HC cell, as well as other prognostic cells in the Sentinel Network, can be configured for a simple buffered logic high or low output to indicate an impending failure event. It can also be used with Ridgetop's PHMPro®, another graphical user interface.

Figure 4 shows an example HC layout.

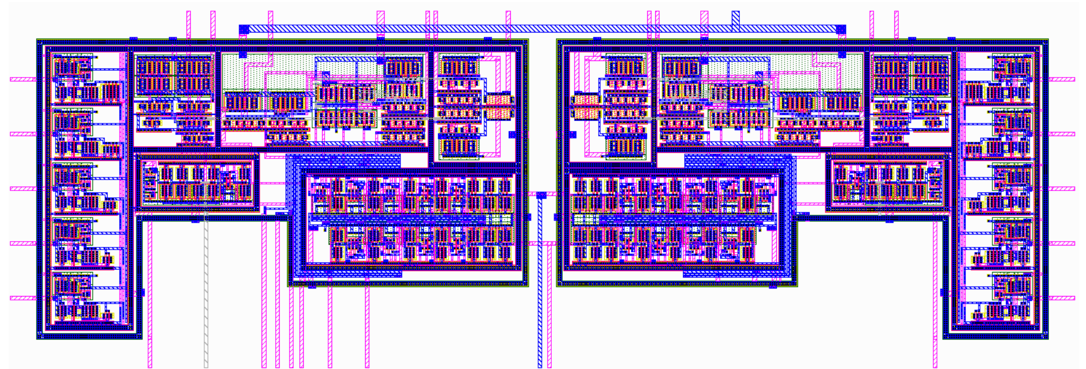

Figure 4: HC layout, 130 nm silicon

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