Technology: An overview of VORAGO's HARDSIL® Technology

The HARDSIL Solution

VORAGO invented and patented its HARDSIL® technology to specifically improve the robustness of bulk CMOS devices to both radiation and high temperature effects. Having proven its manufacturing robustness in several commercial wafer fabs, HARDSIL components are setting new standards for reliability in the harshest electronic application environments. This is accomplished by integrating HARDSIL technology into the commercial bulk CMOS process. Once this is completed the modified fabrication process can be used to manufacture hardened IC products for a broad range of product types: digital logic, memory, mixed signal.

HARDSIL technology reduces charge sharing, reduces transient upset times, and provides complete immunity to latchup. By attacking the problem at the silicon process level, HARDSIL enables the CMOS circuit to operate far more reliably in extreme environments such as radiation and at temperatures in excess of 200°C. By making more robust CMOS IC products available for use in extreme environments, system designers are free to simplify system designs and focus more attention on increasing system performance and reducing SWAP.

HARDSIL enables bulk CMOS IC's for reliable operations at temperatures 100°C higher than mil/aero; it provides a new class of hi-rel products which are latchup immune and can be manufactured in high quality silicon foundries. HARDSIL simultaneously provides radiation hard and high temperature hard IC component solutions for extreme environment applications.

Commercial IC Limitations

The semiconductor industry provides millions of IC components used in the largest electronic systems to the smallest mobile products. Standard commercial CMOS integrated circuits are manufactured using bulk silicon and commercial processes that make the IC circuit sensitive to extreme environments such as radiation and high temperature. Use of Commercial Off The Shelf (COTS) ICs in these extreme environments requires system engineers to employ mitigation techniques to protect them. Such workarounds add cost, and generally increase system Size, Weight and Power (SWAP).

For satellites, the normal practice employed to protect COTS components from space radiation is to: 1) add metal shielding, 2) employ both circuit-level and system-level redundancy (backup) which when taken together, increase payload mass, power, and overall cost. Furthermore, the trade-offs don't truly eliminate the radiation effects, which can reduce duty cycle and reduce error free computational capability for the on-board electronic payload.

In the case of industrial high-temperature applications such as down hole drilling, use of older generation COTS components with complex packaging requirements or secondary cooling for the electronics are typically practiced. The probability of failure increases with temperature. In particular, the effects of high temperature, especially on lifetime reduction, tend to dominate above 85°C for which COTS parts are rarely designed.

A new class of CMOS components rated for use in high radiation and high temperature environments is needed.

Radiation Hardened

HARDSIL technology has been proven to harden ICs to all forms of radiation SEE and TID while delivering superior density and performance relative to current methodologies. HARDSIL is manufactured on bulk silicon wafers yet it equals the latchup immune performance of Silicon on Insulator (SOI) IC product when exposed to the similar radiation and/or temperature conditions.

HARDSIL RH devices can be used to reduce costs of the satellite system design by eliminating the need for many mitigation approaches employed in satellites that

operate in high radiation environments. Alternatively, HARDSIL can be used in addition to COTS because the two broad radiation mitigation approaches are complementary. Satellites using HARDSIL RH IC components throughout will need less area, weight, and power; and will have increased satellite duty life.

VORAGO has performed extensive radiation testing of the HARDSIL technology to prove its leadership position in radiation hardness performance across all measured environments including Total Ionizing Dose (TID), Single Event Latchup (SEL), Single Event Upset (SEU), and other conditions. In short, HARDSIL provides unprecedented radiation immunity. Detailed radiation reports are available from VORAGO.

Temperature Hardened

Advanced geometry (<130nm) Commercial off the Shelf (COTS) devices are not capable of reliable operations at temperatures over 175°C. Multiple high reliability or mission critical electronic market segments including oil and gas exploration/production, aerospace, automotive, medical devices, and energy generation most often rely on old generation CMOS devices (> 0.35um) to cope with high temperature. The use of large geometry CMOS devices limits increased chip density and signal integration. And in some cases older generation IC components are no longer in supply or are hard to find which further burdens the system design and limits technology advances into most high temperature applications.

Latchup and parasitic coupling effects typically observed in COTS devices at temperatures over 85°C can be mitigate by HARDSIL® at temperatures up to and greater than 200°C. HARDSIL's latchup immunity extends the operating range of the CMOS device to temperatures not matched by other technologies of equal circuit gate density. By allowing high temperature designs at the 130nm or smaller technology node, HARDSIL enables SoC integration scaling for fewer components at the board level.

For more information please contact VORAGO at info@voragotech.com