Digest of Tech. Papers The 11th Conf. (1979 International) on Solid State Devices, Tokyo

A — 6 — 1 (Invited)

THE BURIED CHANNEL CCD: AN INHERENTLY RELIABLE TECHNOLOGY

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This Fall marks the tenth anniversary of the invention of the Charged Coupled Device (CCD) by four scientists at Bell Laboratory (1,2). During that time, the technology has come to be used in a wide range of applications including linear and area image sensors, analog signal processors and memory. Both Buried Channel (BCCD) and Surface Channel (SCCD) manifestations have been applied with success.

The analog nature of CCD has made it an obvious choice for high performance image sensors and signal processors, and today as a result of this technology is rapidly gaining dominance in these important areas of component electronics. As applied to memory, CCD has the advantage of great compactness resulting in an area per bit of approximately half that of any other known technology.

Despite this decade of work CCD is still maturing. One of the vital figures of merit of any mature technology is its inherent reliability. Perhaps because of the glamour of CCD, this subject has been relatively little touched upon in previous publications. In this paper we intend to correct this deficit.

The reliability aspects of both the Buried and Surface CCD technology are discussed and results obtained at our laboratories are presented for the first time. As is well-known, the Surface Channel CCD transports the signal charge along the surface at the silicon-silicon dioxide interface, while the Buried Channel CCD transports below the interface at a buried layer. We chose to pursue BCCD in 1971 because of a number of theoretical considerations. These included the fact that BCCD is faster, is insensitive to frequency slewing, and in N-channel form, the electrical field across the oxide has the same sign and lower magnitude than P-channel technology. In addition, the BCCD technology has an intrinsically higher signal to noise ratio.

In order to develop the inherent reliability features of CCD processing, both long term high temperature operating life results in addition to system level test data are discussed. Tests and test data collected are presented which deal with failure mechanisms associated with the BCCD wafer fabrication process including surface inversions, dielectric defects, electromigration, MOS V_{TH} shift, microcracks and dark current degradation. This discussion elaborates on the designed-in reliability features of the BCCD process and presents reliability test data which supports this premise.

The data gathered supports the contention that the BCCD is inherently more reliable than other MOS memory or CCD technologies. This fact coupled with uniqueness of the technology in image sensor and analog signal processing applications, and the density advantage in memory applications, promises a maturing future for BCCD in the family of semiconductor technologies.

REFERENCES

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