

DICE SELECTION IN HYBRID MICROCIRCUITS FOR AEROSPACE APPLICATIONS

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Abstract

Hybrid Microcircuits which bring about miniaturization with better performance and reliability are ideally suited for application specific low volume production requirement of space missions. A large number of HMCs are used in every spacecraft. HMCs generally use passive components and interconnections in thick film form, and active devices (MOSFETs, Transistor and Diode dice) and monolithic ICs (as bare chips) bonded to a substrate. Environmental radiation threat to ICs and other active circuitry is one of the major causes of failures in HMCs. The ionizing radiation present in the Van Allen Belt penetrates the satellite resulting in the excitation of electrons in the semiconductor valence band to conduction band in the active circuit and can be trapped. Secondary photon radiation, which are generated due to slowing down of high energy particles also strike interior of the spacecraft. The total interaction of various charged particles and photons to the internal circuitry of HMC depends on mass, charge state, kinetic energy of the striking photon as well as on the mass, charge and density of the die structure internal to HMC. The MOS die is prone to failure due to total ionization dose as well as single event effects which in turn may cause HMC failure. HMCs for space applications are mostly characterized with die passivation and hermetically sealed packages for its inherent advantages. In spite of the advantages offered by hermetic sealing like reliability, radiation shielding, out gassing etc, the radiation hardened dice are preferred for realization of HMCs for space systems. A feasibility study is carried out for using MIL and Commercial grade dice in HMCs without compromising on reliability aspects. The layout design, die attachment process, testing and extensive qualification become important in HMC apart from hermetic sealing so as to avoid catastrophic failure. This article details the radiation phenomena and its effects on dice used in HMCs. The advantages of hermetically sealed packages and use of MIL/Commercial grade dice in HMCs along with various mitigation techniques to have reliable circuit meeting the desired performance in space environment are also presented.

Keywords: Radiation, Commercial die, RHA, HMC, Hermetic sealing