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RELIABILITY PHYSICS OF AEROSPACE ELECTRONICS: FAILURE-ORIENTED-ACCELERATED-TESTING (FOAT), ITS ROLE AND SIGNIFICANCE

E. Suhir,
Bell Laboratories (ret), Portland State University, and ERS Co.,
727 Alvina Ct., Los Altos, CA 94024, USA, suhire@aol.com, 650-969-1530

Abstract: An highly focused and highly cost effective failure oriented accelerated testing (FOAT) [1-6] suggested about a decade ago as an experimental basis of the novel probabilistic design for reliability (PDfR) concept [7-23] is intended to be carried out at the design stage of a new electronic packaging technology and when high operational reliability (like the one required, e.g., for aerospace, military, or long-haul communication applications) is a must. On the other hand, burn-in-testing (BIT) [24, 25] that is routinely conducted at the manufacturing stage of almost every IC product is also of a FOAT type: it is aimed at eliminating the infant mortality portion (IMP) of the bathtub curve (BTC) by getting rid of the low reliability "freaks" prior to shipping the "healthy" products, i.e., those that survived BIT, to the customer(s).When FOAT is conducted, a physically meaningful constitutive equation, such as the multi-parametric Boltzmann-Arrhenius-Zhurkov (BAZ) model [26-31], should be employed to predict, from the FOAT data, the probability of failure and the corresponding useful lifetime of the product in the field, and, from the BIT data, as has been recently demonstrated [25], - the adequate level and duration of the applied stressors, as well as the (low, of course) activation energies of the "freaks". Both types of FOAT are addressed in this review using analytical ("mathematical") predictive modeling [32-36], as well as FOAT carried out at the electronic product development stage. The general concepts are illustrated by numerical examples. It is concluded that predictive modeling should always be conducted prior to and during the actual testing of aerospace electronics and photonics and that analytical modeling should always complement computer simulations. These two major modeling tools are based on different assumptions and use different calculation techniques, and if the output data obtained using these tools are in agreement, then there is a good reason to believe that these data are sufficiently accurate and trustworthy. Future work should be focused on the experimental verification of the obtained findings and recommendations.

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