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Failure oriented accelerated testing in electronics and photonics materials science and engineering: Role, significance, attributes, challenges

Ephraim Suhir
Portland State University, USA

A highly focused and highly cost effective Failure-Oriented-Accelerated-Testing (FOAT) was suggested about a decade ago as an experimental basis of the novel Probabilistic Design for Reliability (PDfR) concept. FOAT is supposed to be carried out, when a new technology or a new design are considered and when high operational reliability, like the one required for aerospace, military, or long-haul communication applications, is required. On the other hand, Burn-in-Testing (BIT) that is routinely conducted at the manufacturing stage of almost any IC product is also of a FOAT type: it is aimed at eliminating the Infant Mortality Portion (IMP) of the Bath Tub 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 at the design stage and BIT at the manufacturing stage are conducted, a suitable and physically meaningful constitutive equation, such as, e.g., the multi-parametric Boltzmann-Arrhenius-Zhurkov (BAZ) model, could 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,-the adequate level and duration of the applied stressors, as well as the (relatively low, of course) activation energies of the "freaks". Both types of FOAT are addressed using analytical ("mathematical") predictive modeling, and the general concepts are illustrated by numerical examples. It is concluded that predictive modeling should always be conducted prior to actual testing and that analytical modeling should always complement computer simulations: these two major modeling tools are based on different assumptions, use different calculations techniques, and if the calculated data obtained using these tools are in agreement, then there is a good reason to believe that these data are accurate and trustworthy. Future work should be focused on the experimental verification of the obtained findings and recommendations.