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Abstract

Boltzmann-Arrhenius-Zhurkov (BAZ) Equation and Its Application in Electronics and-Photonics (EP) Reliability-Physics (RP) Problems: Review and Extension

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Abstract:

Application of Boltzmann-Arrhenius-Zhurkov (BAZ) equation in electronics-and-photonics (EP) reliability-physics (RP) problems enables quantifying, on the probabilistic basis, the performance (actually, the never-zero probability of failure under the anticipated loading conditions and after the given time in operation) of an EP material, thereby making a viable device into a reliable product, with the predicted, adequate and, when necessary and appropriate, even specified probability of failure in the field. In the review part of the analysis the following EP RP problems are addressed with an objective to show the significance and attributes of the approach based on the BAZ equation: 1) an EP package subjected to the combined action of two or more stressors (such as, say, elevated humidity and voltage); 2) three-step concept (TSC) in modelling reliability, when the RP-based BAZ equation is sandwiched between two well-known statistical models - Bayes formula (BF) and beta-distribution (BD); 3) static fatigue of an optical silica fibre intended for high-temperature applications; 4) low-cycle fatigue life-time of solder joint interconnections and 5) life-time of electron devices predicted from the yield information. The extension part addresses some important aspects of burn-in testing (BIT) of manufactured EP products comprised of many mass-produced components. Its objective is to shed, using BAZ equation, some quantitative light on the RP of the BIT process. The general concepts and analyses in both parts of the analysis are illustrated by and through practical numerical examples. It is concluded that application of BAZ equation in EP RP problems, and particularly in those encountered in aerospace engineering, enables quantifying, on the probabilistic basis, the performance (actually, the probability of failure under the anticipated loading conditions and after the given operation time) and the lifetime of an electronic or a photonic material. This makes a viable device into a reliable product, with the predicted, adequate and, when necessary and appropriate, even specified never-zero probability of failure in the field.

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