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Modelling of Multilayer Delamination

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Nowadays, die stacking is gaining a lot of attention in the semiconductor industry. Within this assembly technique, two or more dies are vertically stacked and bonded in a single package. Compared to single-die packages, this leads to many benefits, including more efficient use of space, faster signal propagation, reduced power consumption, etc.
Delamination, i.e., the separation of two intendedly connected layers, is a common failure attribute of semiconductor dies. Measured from 0 to 100 percent, the delamination of a single die is typically modeled by the beta distribution. Considering that the delamination levels of stacked dies correlate, there is need for a model of the whole stack, which is a probability distribution on the unit hypercube.
Contrary to, e.g., the normal distribution, there isn't a standard extension of the beta distribution to multiple dimensions. Thus, we present and extensively evaluate three different approaches how to obtain an appropriate distribution on the unit cube. These are the construction of multivariate beta distributions using ratios of gamma random variables, the application of Gaussian copulas, and the factorization of the joint distribution in conditional ones that are individually modeled via beta regression. The model evaluation is based on simulated and real delamination data.
Finally, we extend the proposed models in a way that they are able to describe delamination over time. Thus, we provide an advanced framework for multivariate delamination modeling, which is of particular value for higher degrees of integration, new package concepts, and assessment of product qualifications.

Keywords

Beta-distribution, delamination, semiconductors

Classification

Both methodology and application

Primary authors: Dr LEWITSCHNIG, Horst (Infineon Technologies Austria AG); PODVRATNIK, Renato (Infineon)

Presenter: PODVRATNIK, Renato (Infineon)

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