Area Scaling of failure probabilities for semiconductor devices

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In semiconductor production random defects can lead to early fails of devices. In the production process, the defect density level is continuously reduced. Remaining defects are weeded out, e.g. by optical inspections, electrical testing, statistical postprocessing.

Nevertheless, to prove the early life failure rate of a semiconductor product, devices are randomly sampled. This is done on representative devices, denoted reference products. They are stressed in a so-called burn-in study. During this their early operating hours are simulated.

The fails in the burn-in study are counted, and the portion of failing devices, i.e. the p of the binomial distribution, is inferred by means of the Clopper-Pearson interval estimator. This p refers to the chip size of the reference product. Follower products might have a different chip size. If a device is smaller in size, the likelihood to have a defect is lower. This is called area scaling.

Typically the whole area of the reference product is scaled to the follower products. Nevertheless, specific subareas of semiconductor devices differ in their sensitivity for defects. This results in area specific failure probabilities.

The situation is comparable to the reliability block diagram, where the overall reliability is calculated based on the failure probability of each component. In our case we estimate the failure probability of each subarea (i.e. component), based on the observed fails and on the overall failure probability.

A new model is presented that maps the conditional probability for fails of each subarea with the observed values. With this, it is possible to calculate their failure probabilities. The result is consistent with the overall failure probability, estimated with the Clopper-Person method.

The scaling of follower-products can then be done separately for each subarea. This results in a more accurate estimation of p for follower products than in case of the classical area scaling.

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