Thesis project available

Prognostics and Health Management (PHM)

(duration: 10-12 months)

❖ Title of the research:

Development and implementation of uncertainty propagation methods for the estimation of early-life failure probability of semiconductor devices.

❖ Context of the research

In the semiconductor manufacturing industry, monitoring the quality-level of the produced electronic devices and estimating their reliability is essential, especially for safety-critical applications such as air and land transportation and industrial plants. One of the main concerns of the manufacturers is to guarantee that the devices work when placed in service and do not fail during their early-life stages, which are characterized by larger failure rates than during the useful life. Burn-in is the method mostly employed by the manufacturer to ensure the quality and reliability of semiconductor devices and to reduce their failure rate due to manufacturing defects. It consists in the operation of the manufactured devices under accelerated stress conditions, such as high temperature and voltage. The number of components that have failed during the BI tests is used as input to the Clopper-Pearson Estimator for the computation of the upper one-sided confidence interval of the early life failure probability, i.e., the proportion of the early failures.
In practice, performing burn-in is costly and time-consuming, particularly for new technologies. With the advancements of artificial intelligence algorithms and computational capabilities, Artificial Intelligence (AI) methods have been developed for the prediction of the number of defective semiconductor devices within a production lot by resorting to signals measured during the production process. However, effective and reliable implementation of the AI methods in a real industrial setting requires the correct representation of the prediction error and the other sources of uncertainty in order to obtain a satisfactory prediction of the early life failure probability.
In this regard, the present thesis project aims at developing and implementing uncertainty propagation methods such as Monte Carlo simulation, bootstrapping and bagging approaches, combined with Clopper-Pearson estimator for the estimation of the distribution of the early-life failure probability of the semiconductor devices.

The thesis will be developed in collaboration with INFINEON within the European Project IREL4.0

❖ Objective of the research

Investigation and development of uncertainty propagation methods, development and pilot case examination, with software implementation of the method explored.

❖ Work Phases

- Analysis of the information available for the development of the method (AI models for the prediction of the BI-relevant failures and real BI data;
- Analysis of the possible solution methods for the estimation of the early-life failure probability distribution;
- Selection of the most promising solution method;

- Development of the selected solution method;
- Analysis of the obtained results.

❖ Required skills

- Good knowledge of statistical and non-statistical data processing technologies and techniques;
- Good knowledge of mathematical formulations and model development.
- Interest in developing innovative algorithms to tackle real applications;
- Good knowledge of MATLAB, Python and/or R programming.

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