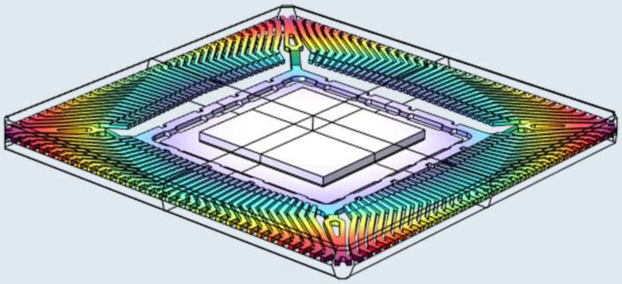

Warpage assessment in IC packaging

Prediction of the deformed shape of a plastic package structure is crucial for different process steps. A simple approach is proposed to describe the complex materials and processes involved.

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Abstract

Warpage is investigated on different types of manufacts: a simple dual beam sample composed of copper and molding compound, a single package device, and a full strip made as assembly of multiple package devices. A common FEA approach is developed to describe warpage for all structures analyzed. Based on findings, warpage and shape variation as a function of temperature of the single package device as well as bilaminar sample is well predicted by the model. This is confirmed by a comparison with experimental findings. However, when it comes to large thin structures, like strips or even panel-level systems, the model provides a poor warpage shape prediction probably due to non-linear effects. Improvement of the model in terms of non-linearities and material constitutive laws needs to be assessed to obtain accurate predictions of package warpage behavior after IC manufacturing process.

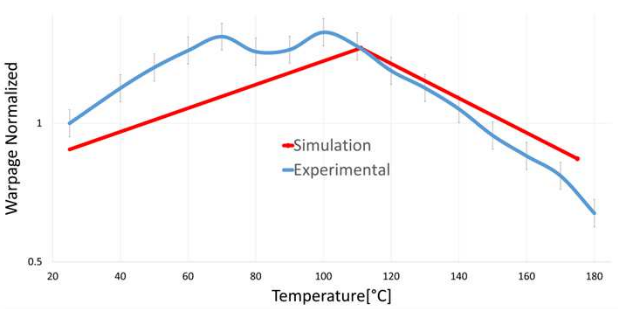

FIGURE 1. Comparison between experimental and simulated warpage of bi-material beam as a function of temperature.

Methodology

The deformed shape of the different manufacts subjected to uniform thermal load is modeled by dividing the numerical problem in two branches corresponding to the rubbery and glassy state of the resin encapsulant, which is delimited by the glass transition temperature (*Tg*).

The warpage, defined as the difference in height between the lowest and the highest point on the package surface, has a bilinear behavior with respect to temperature, with a change in slope around *Tg* which well matches the experimental observations. Linear viscoelastic analysis are also run to study the behavior around *Tg.*

Results

The proposed approach well predicts the behavior of package and dual beam structures in terms of slopes of the bilinear curves. Initial warpage values after assembly still needs to be assessed to consider the residual stresses coming from the process. This could be related to lack of an appropriate constitutive model of the resin.

The proposed methodology is indeed useful for prediction of package deformation during post-manufacturing processes which involve a package with a fully cured encapsulant, like soldering or reliability thermal cycling. It must be noted that for large and thin assembly systems real shape and warpage values strongly disagree with model predictions.

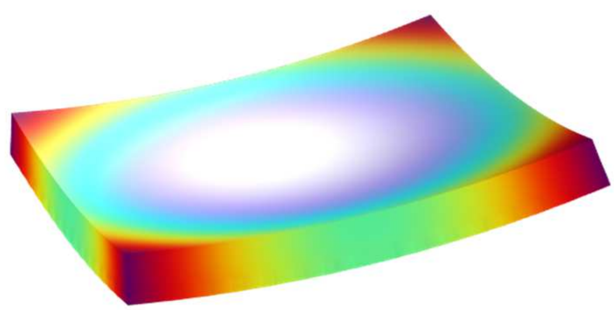

FIGURE 2. Deformed shape of a package assembly.

REFERENCES

1. Molding Compound for 5G Application, International Conference on Electronic Packaging Technology (ICEPT),2021

2. C. Kim, et al. "Warpage Analysis of Electroplated Cu Films on Fiber-Reinforced Polymer Packaging Substrates " Polymers, 2015