ATDI

Doctoral School on Material Sciences and Technologies
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Semester Report - Autumn 2020

Creep in soldering materials: Finite element analysis

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Introduction

- SINCE 2006

The European Parliament and the Council of the European Union.

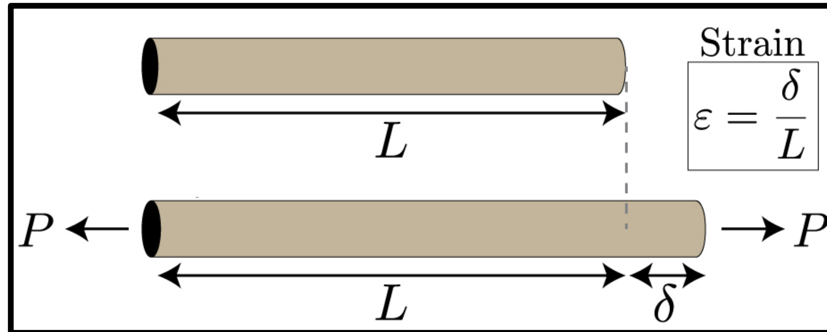
Restricted materials:

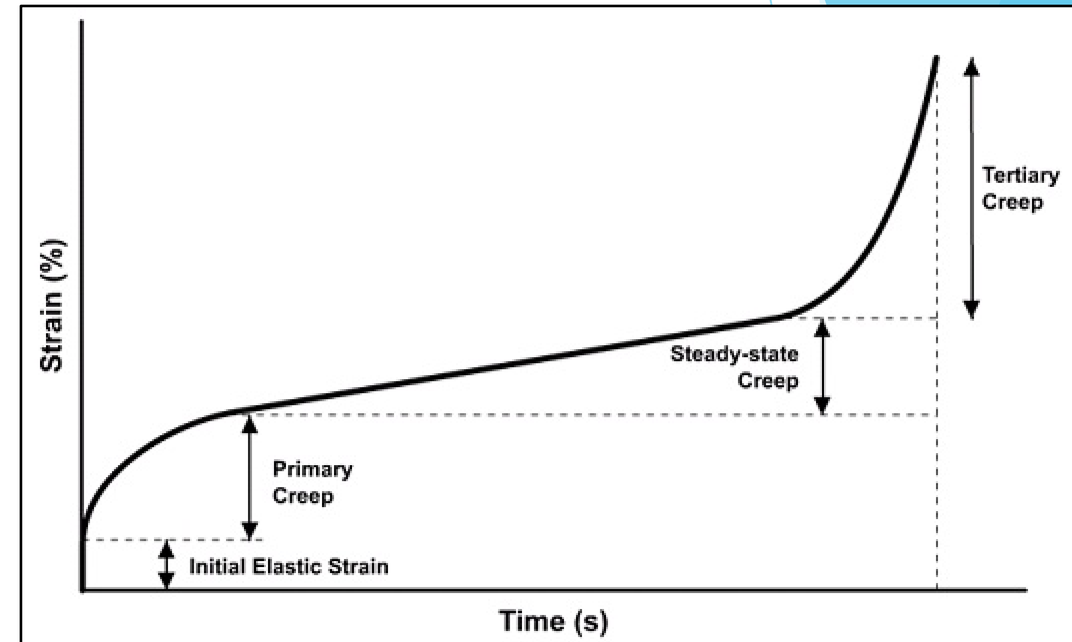
- *Lead*
- *Mercury*
- *Cadmium*
- Hexavalent chromium
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ethers (PBDE)

Restriction of Hazardous Substances Directive

Lead-free (unleaded) soldering materials were introduced to the market.

Creep concepts and Anand Solder Model





- **constant stress**
- **time**
- **temperature above $0.5\ T_m$**

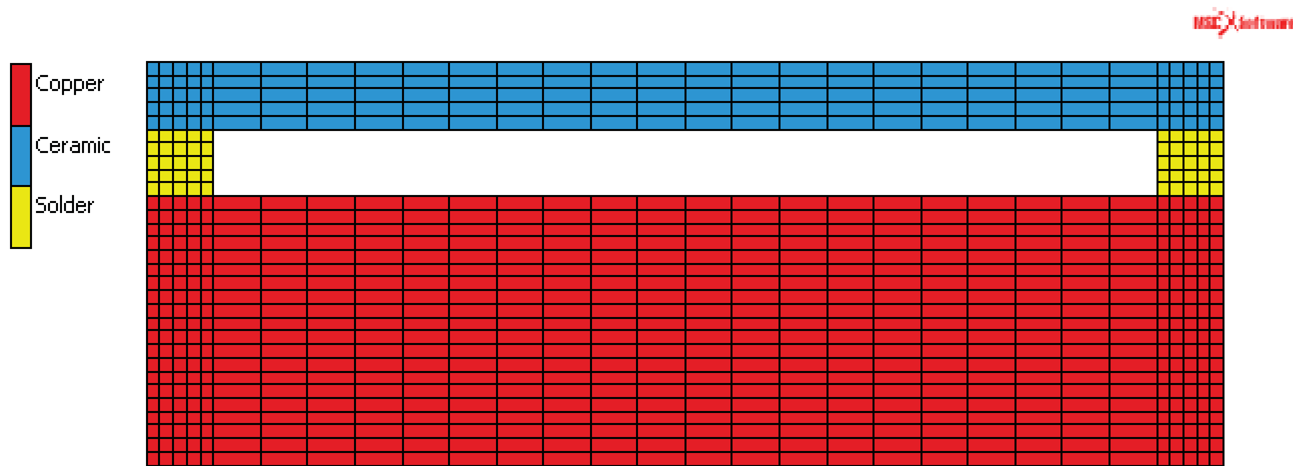
Anand model (1982) consist of a set of constitutive equations for large, isotropic, viscoplastic problems.

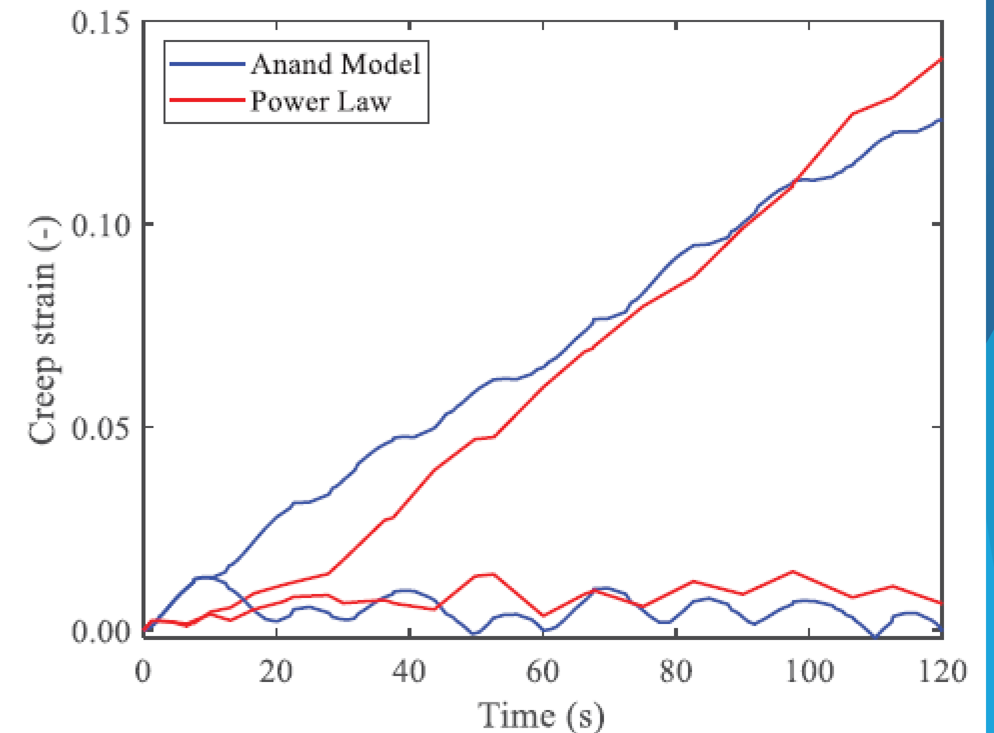
- Two equations.
- Nine material parameters.

Results

- FIRST AND SECOND SEMESTER

Comparison of the thermal-mechanical behavior of a soldered stack influenced by the choice of the solder.



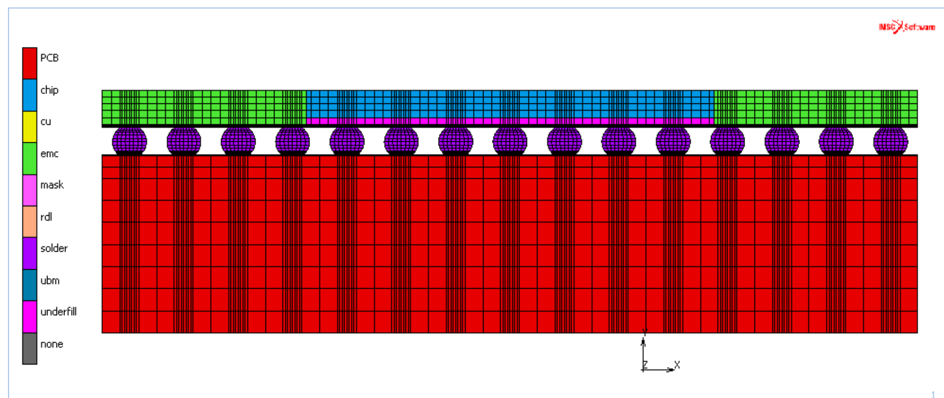


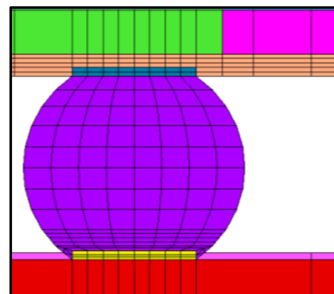
Using the results from the Anand Model, power-law parameters were obtained for SAC305 solder. The accuracy of the results is acceptable with an error of nearly 10% as compared to the simulation values. However, the method used was based on the principle of relative error.

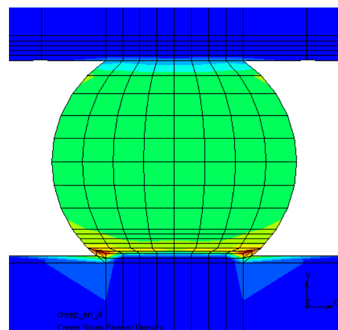
Results

- THIRD SEMESTER

Solder joint reliability based on creep strain energy density for lead-free solder materials: SAC305, SACQ, SACR, and InnoLot







This research combines:
- Creep models
- Reliability models.
- Doped SAC Solders (SACX) comparison.

Doped SAC Solders

Solder	Sn	Ag	Cu	Bi	Ni	Sb
SAC-R	96.62	0.00	0.92	2.46	0.00	0.00
SAC-Q	92.77	3.41	0.52	3.30	0.00	0.00
InnoLot	90.95	3.80	0.70	3.00	0.15	1.40

SAC Solders

Alloy	Range (%)		
	Sn	Ag	Cu
SAC 305	96 – 97	2.8 – 3.2	0.3 – 0.7
SAC 387	95 – 96	3.6 – 4.0	0.5 – 0.9
SAC 405	95 – 96	3.8 – 4.2	0.3 – 0.7

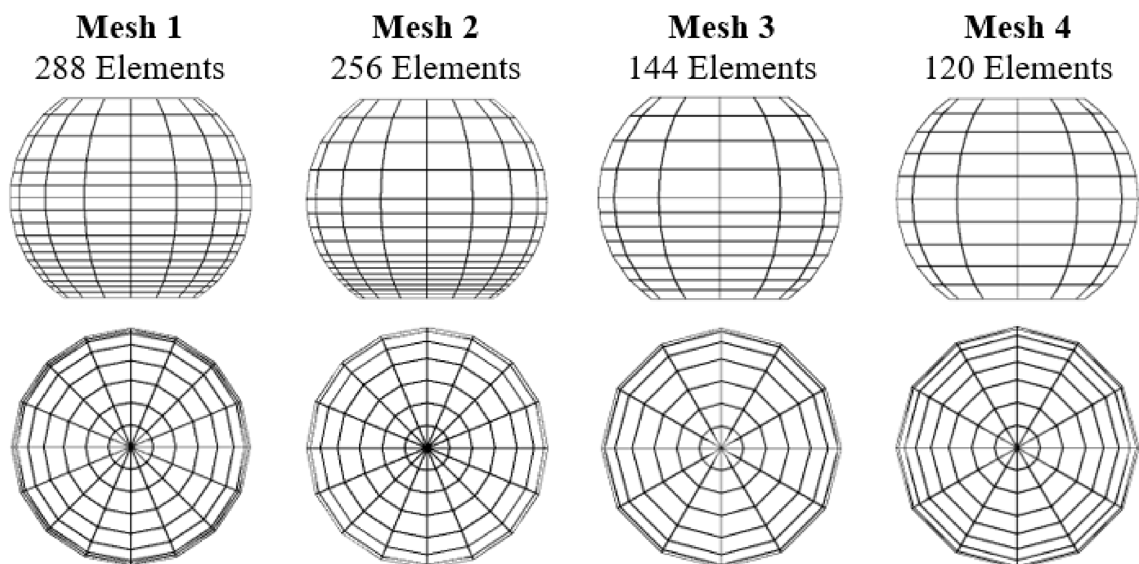
Results

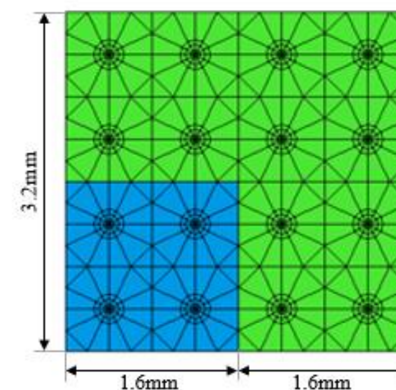
- CURRENT SEMESTER

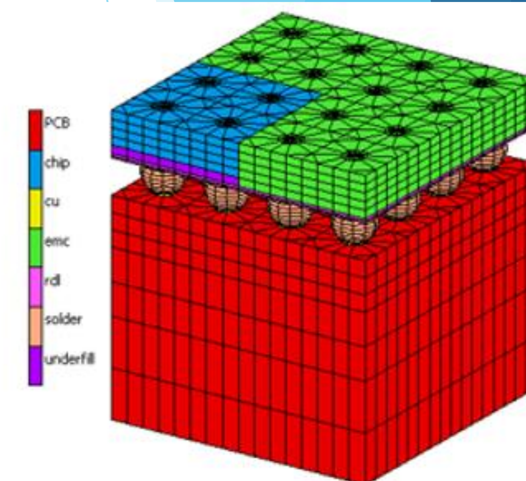
FOWLP 3D Model Texas Instruments IC

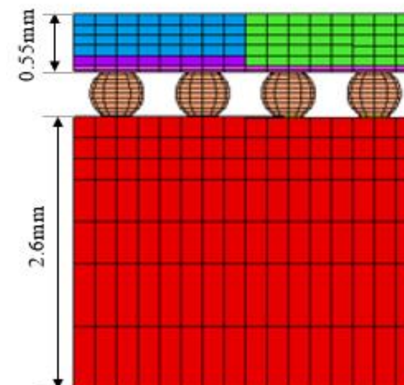
THE FOLLOWING RESEARCH FOCUSES ON:

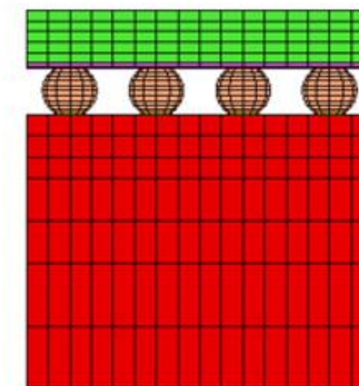
- MESH DENSITY AND TIME-STEP VARIATION.



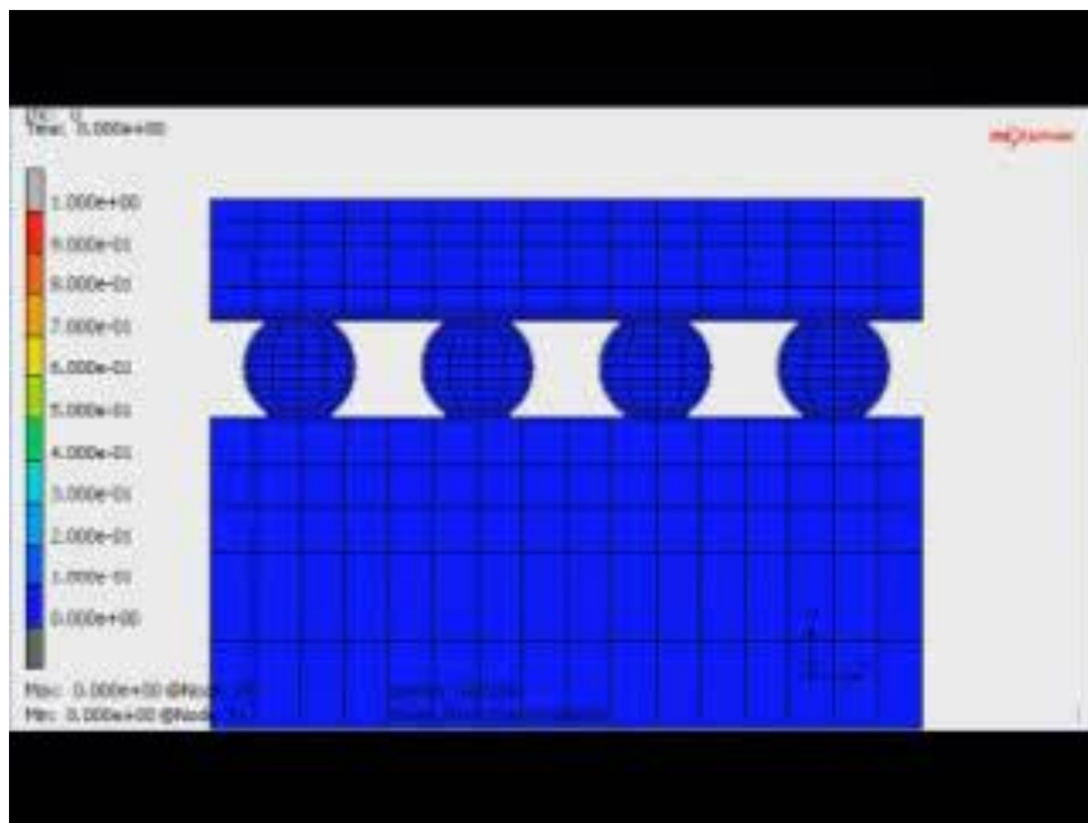




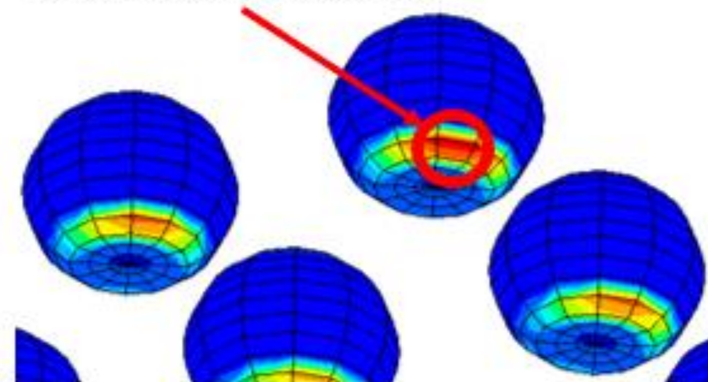


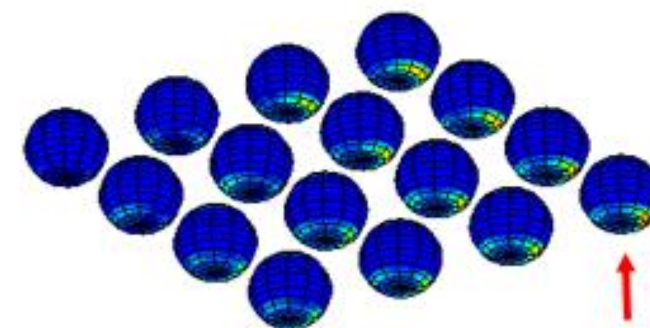


Demonstration of the simulation



Critical node location





Critical solder ball

Future work

- THE LITERATURE RETRIEVED DURING THE FIRST YEAR WILL BE CONDENSED IN A JOURNAL ARTICLE SUMMARIZING THE FUNDAMENTALS OF CREEP DEFORMATION, MATHEMATICAL MODELS, FREE-LEAD COMPOSITES, AND ELECTRONIC PACKAGING EVOLUTION.
- THE EFFECTS OF MESH DENSITY AND TIME-STEP CUSTOMIZING FOR THE 3D MODEL WILL BE SUMMARIZED IN ANOTHER ARTICLE.

Thanks for your kind attention

Questions?