MODELING OF THE AUTOMATIC THERMOPLATIC TAPE PLACEMENT (ATP) PROCESS

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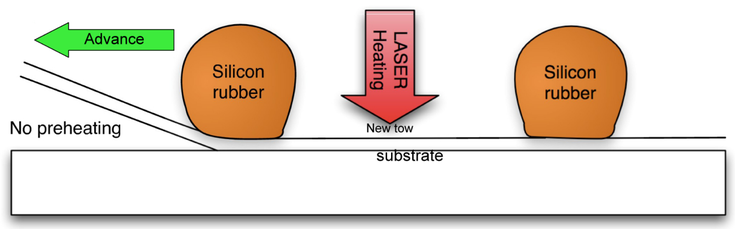
PROCESS PRINCIPLE

Two steps, out-of-autoclave, composite forming process.

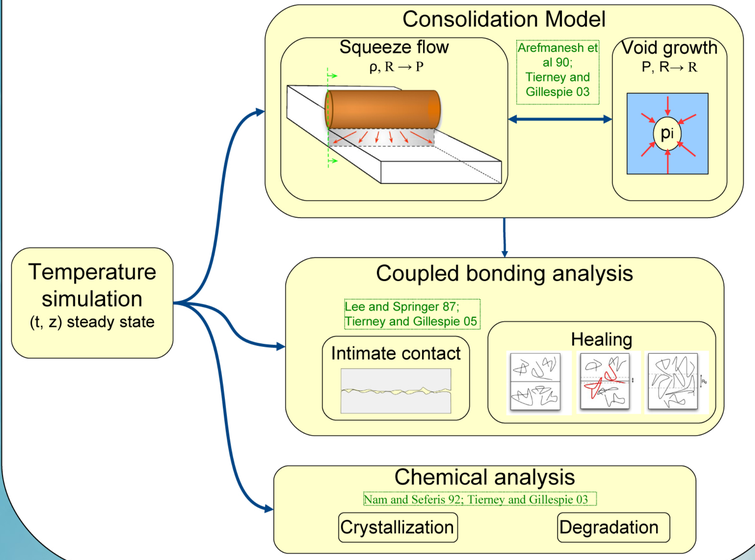
- **Step 1** : Automatic placement of successive thermoplastic prepreg tape



- **Step 2** :Followed by consolidation under vacuum

Goal: Understand the link between process parameters and final quality of the laminate.
Method : modeling and simulation of the main material and process physics

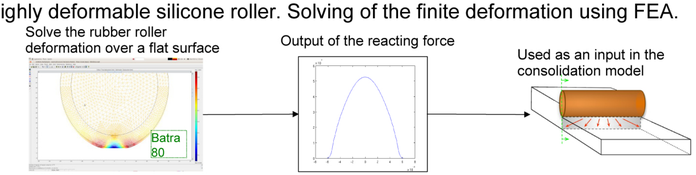
EXISTING CDS SIMULATION TOOL INCORPORATES MULTI-PHYSICS ATP MODEL



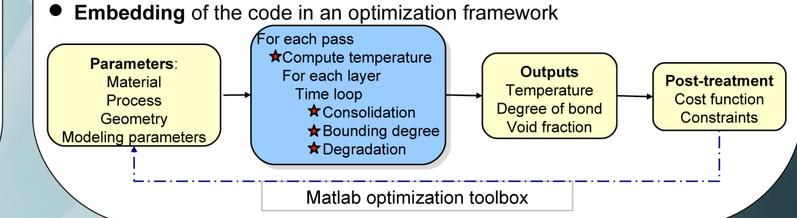
IMPROVEMENT OF THE CODE

- **Optimization** : rewritten in Matlab
- use of vectors and matrices
- use of built-in routines (linear algebra, Runge Kuta, optimization)
→ CPU speed improvement: ~5 times faster

- **Process Adaptation** to simulate EADS industrial head
- Laser heating Sonmez and Hahn 05
- Thermal contact resistance between layers Barasinski et al. 11
- Highly deformable silicone roller. Solving of the finite deformation using FEA.



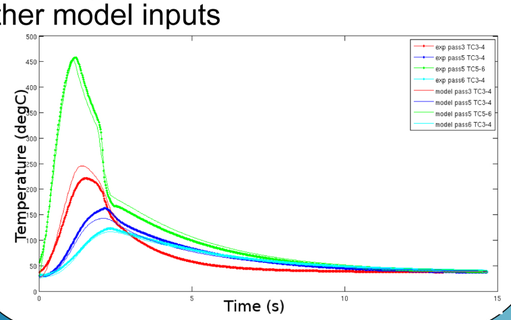
- **Embedding** of the code in an optimization framework



Thermal Model Validation

Find Thermal parameters that minimize Cost function Error : $\sum (T - T_{exp})^2$

→ Optimized parameters include Laser Efficiency, layer contact resistance and other model inputs



ONGOING WORK PROCESS OPTIMIZATION

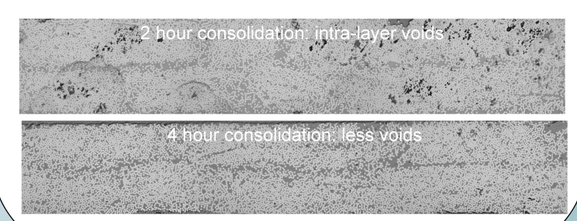
Maximize process throughput for a given required quality
- Maximize head speed
- Consider quality improvement over multiple passes

Find **Parameters:** Velocity Power of the Laser *that* **Cost function:** maximize velocity **Constraint:** Good bounding No degradation Low void fraction

FUTURE WORK

Modeling the second step of consolidation under vacuum.

We first need to understand the physical phenomena that allow a reduction of voids.



ACKNOWLEDGEMENTS

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