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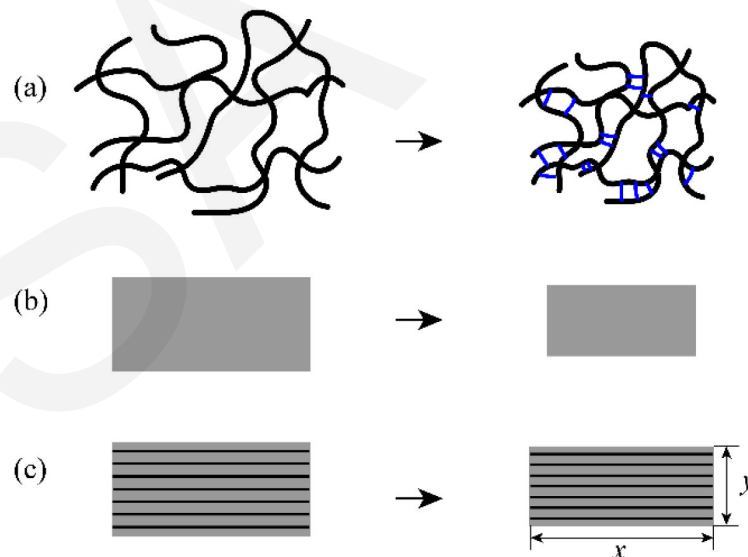
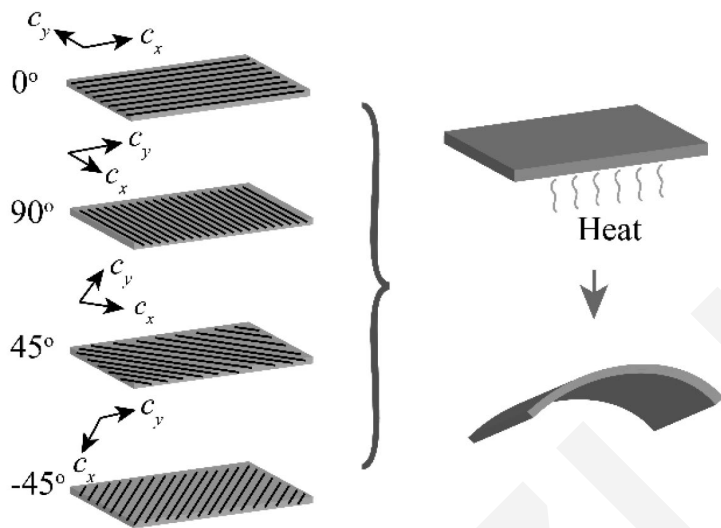
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# Analysis and control of cured deformation of fiber-reinforced thermosetting composites: a review

**Key words:**

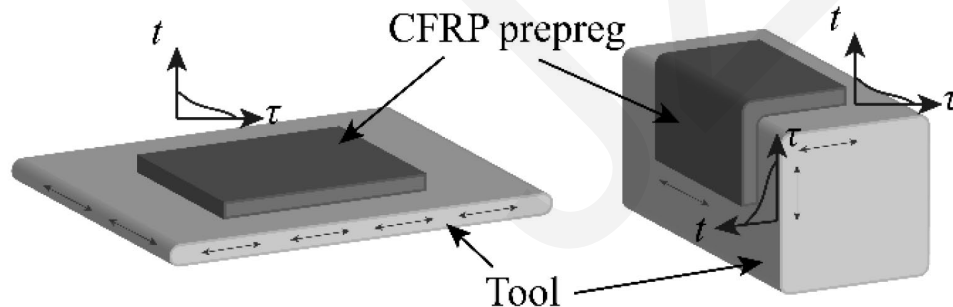
Carbon fiber-reinforced polymer (CFRP); Cured deformation; Finite element analysis (FEA); Process modeling; Control methods

# Mechanisms of Composite Cured Deformation



## 01 Thermal deformation

## 03 Chemical shrinkage of resin



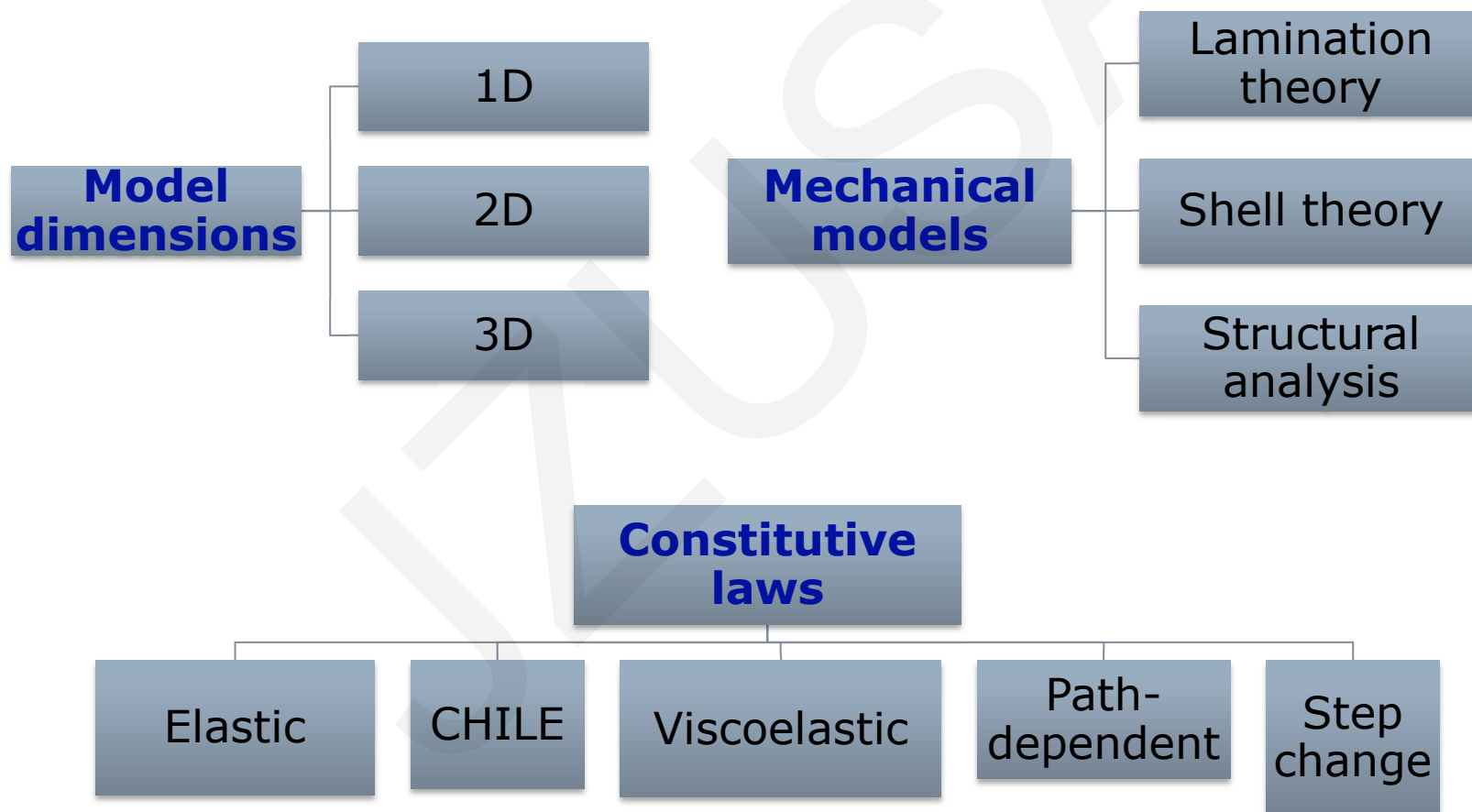
## 04 Others including: resin flow, fiber volume fraction gradients, stacking sequence, temperature gradients, moisture swelling, fiber wrinkling, degree of cure (DOC) , component size and shape, et. al,...

## 02 Tool-part interaction



# Five Representative control methods

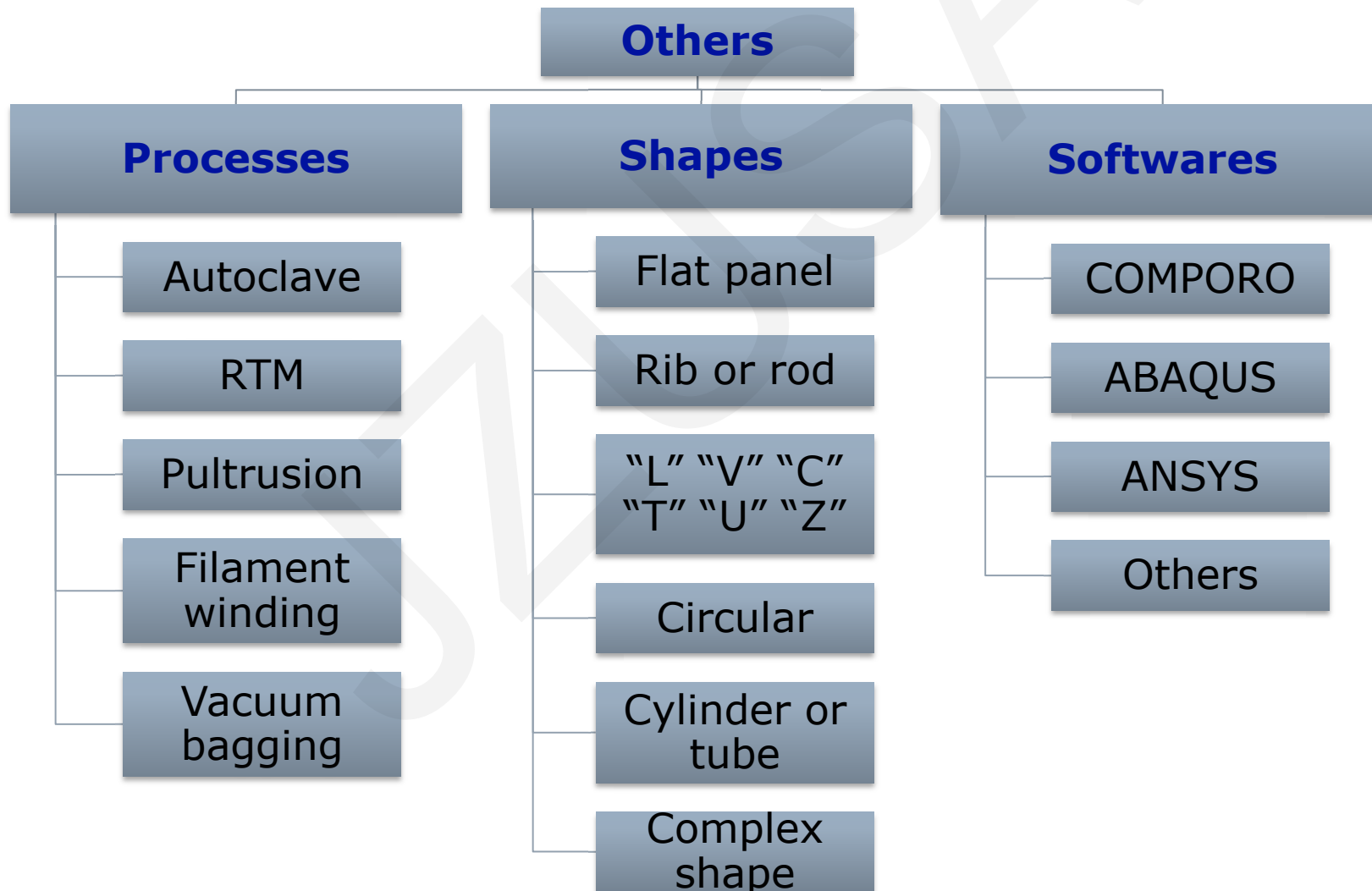
## 1 Die surface compensation





# Five Representative control methods

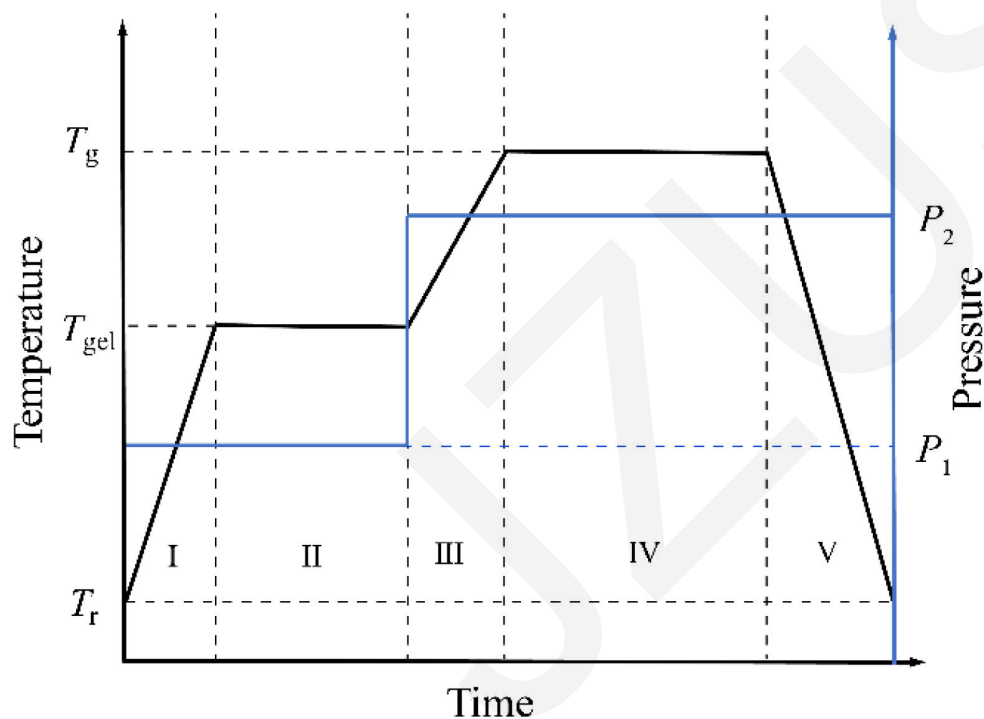
## 1 Die surface compensation





# Five Representative control methods

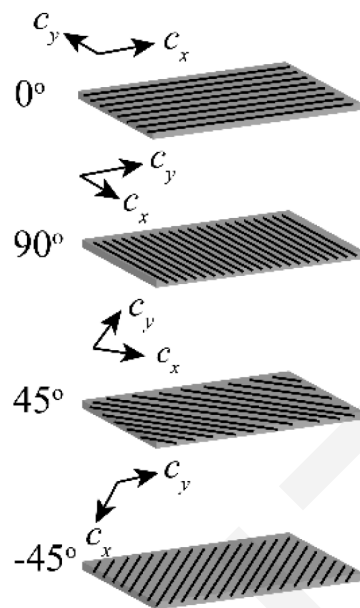
## 2 Process optimization



- 01 Cure cycle
- 02 Cure temperature
- 03 Temperature ramp
- 04 Cooling rate
- 05 Cure time
- 06 Pressure

# Five Representative control methods

## 3 Structure optimization



Laminate thickness



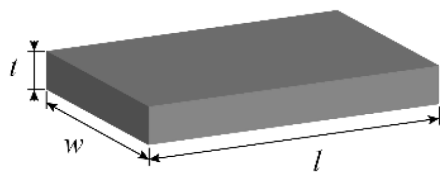
Laminate stacking sequence



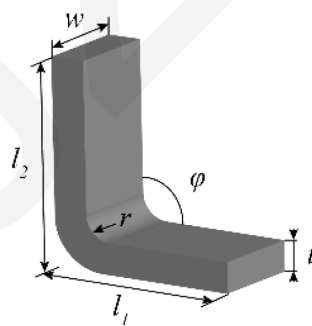
Dimensions



Fiber volume fraction



(a)



(b)



# Five Representative control methods

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## 4 Tool-part contact optimization

- 01 Fluorinated ethylene propylene (FEP) release sheets
- 02 Tool materials
- 03 Tool surface coarseness
- 04 Different setups

## 5 Development of other measures

- 01 Resin
  - New resin
  - Additives
- 02 New curing processes
  - Radiation curing
  - Microwave curing

# Discussions and Conclusions

01 The basis of each control method

02 The advantages and disadvantages of each method and its suitable scope

03 Qualitative control effects of methods

04 This problem has not been resolved fundamentally. Sustained efforts from all sides are still needed to overcome this problem.

