Composites 2.0: Optimal design

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What is “Composites 2.0”

**Composites 1.0**
- Hand-made analog technology
- Structure of 2D
  - 0°
  - 45°
  - 90°
  - Stacking plies

**Composites 2.0**
- Digital manufacturing
- Shape (3D)
- Direction
- Density
- 5D automatic manufacturing
  - 5D = 0° + 45° + 90° + Density

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Pursuing Excellence
New industrial revolution by Composites 2.0

Factory

Internet

Optimization
Fabrication simulation

3D CAD Data
Loading condition

Delivery

Optimization of fabrication process

3D Printer

Internet

Products
New design space by fiber curvature
Digital control of fabrication process
Sensing & simulation of fabrication process
(2) Example of Optimal design

Does the composites with curved fibers really have superior properties?
Fracture Index  (Tsai-Wu fracture rule)
Tsai-Wu value > 1 $\rightarrow$ Fracture
Tsai-Wu value is obtained with FEM
Layout of fibers

Flow line model of perfect fluid
Source, sink and vortex

Advantages
Smooth and continuous lines can be obtained
No-cross lines
Smaller number of design parameters
Results of optimization (GA)

Fiber direction

90°

0°

y

x
Comparison

Tsai-Wu values
(a) 0.64
(b) 1.81

(b) 0° UD

65% decrease
Milestones for Composites 2.0

- Static and cyclic failure of locally curved fibers
- Strength evaluation of entirely continuous fiber composites
- Limit of fiber curvature from fabrication process
- Fabrication process simulation considering void and thermal deformation
4. Conclusions

(1) Composites 2.0 is shown
(2) The possibility of superior results with curved fibers is shown.
(3) Milestone of composites 2.0 is shown

Perfect automated machines will be given after 15 years. However, product optimized processes will be shown within a year.