

The Lenovo logo is displayed in white, italicized lowercase letters on a red rectangular background. The background is part of a larger, layered graphic that resembles a folded piece of paper or a ribbon, with various shades of red and dark red. The main title is on a dark red section, and the author information is on a black section at the bottom right.

lenovo[®]

Applying Carbon Fiber Reinforced Plastics (CFRP) as Laptop Enclosures

Haoning, LNRD, LENOVO

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Decoration – Continuous Process – Cost Target

A red geometric shape, resembling a stylized arrow or a folded piece of paper, pointing towards the right.

General Information

Lenovo was



1984
Founded



1994
PC Division
Established



1997
#1 in China



1999
#1 in APAC



2005
Acquisition of
IBM PCD



2008
Entry to
Fortune 500
(#499)



2010
Joint-Venture
with NEC



2011
▪ Medion
▪ Re-entry to
Fortune 500
(#450)



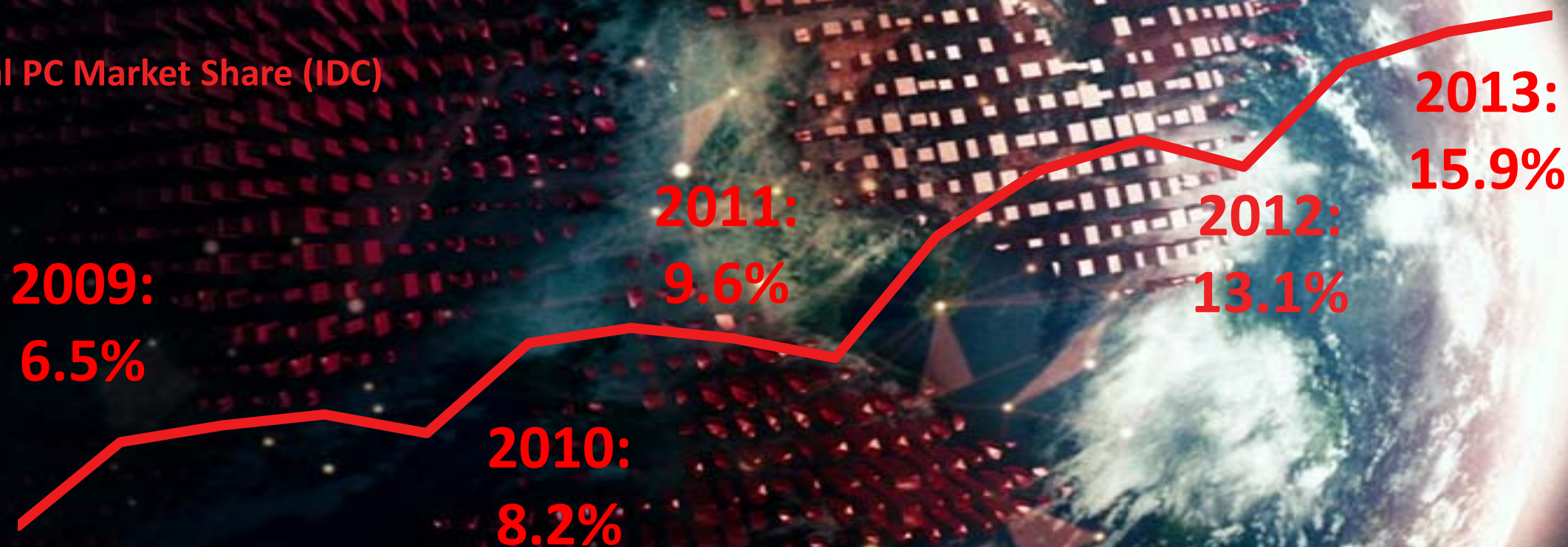
2012
▪ 3rd-Entry to
Fortune 500
(#370)
▪ Partnership



lenovo FOR
THOSE
WHO DO.

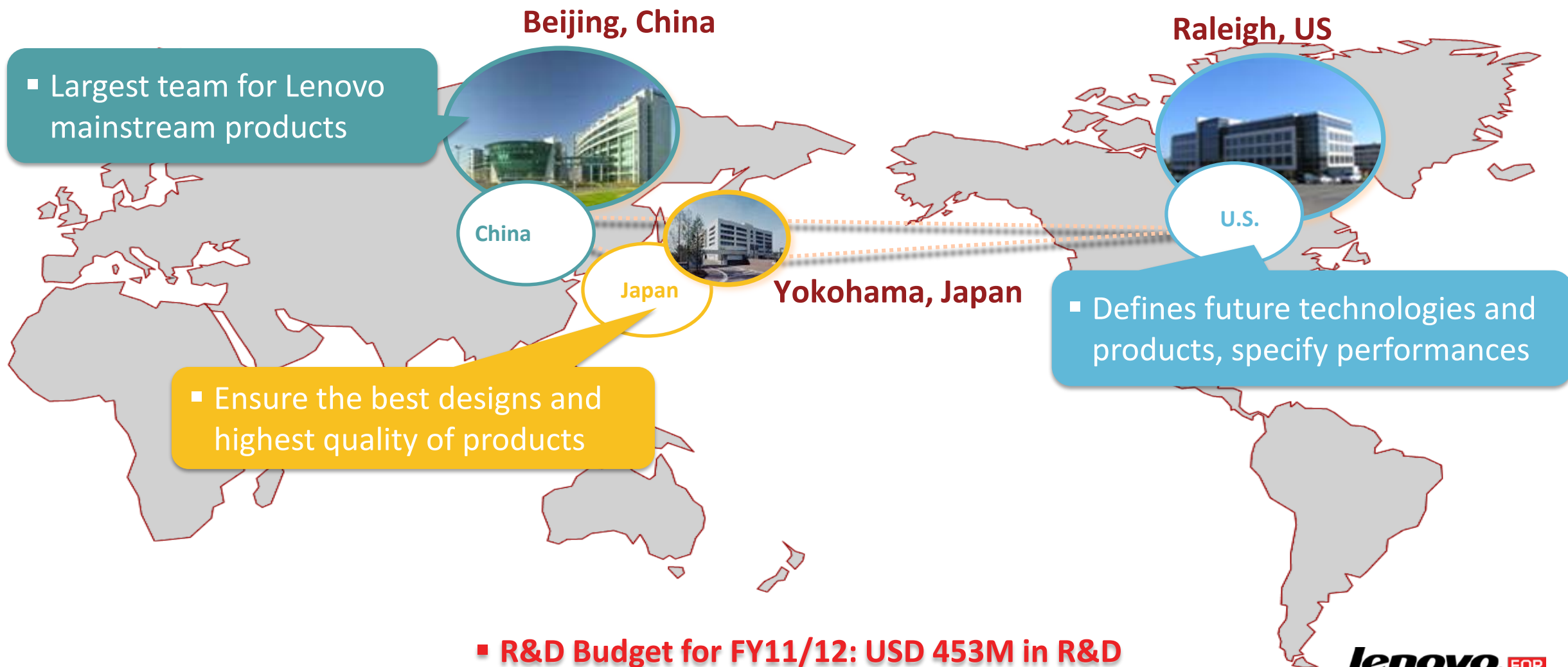
Lenovo is...

General PC Market Share (IDC)



A \$30B global personal technology company
with 30,000 people and customers in 160+ countries.

Lenovo R&D



Integrated Structure

Market Demands



THINK

BUSINESS GROUP (TBG)

- Premium PCs
- Tablets
- Enterprise

LENOVO

BUSINESS GROUP (LBG)

- Mainstream/Entry PCs
- Tablets
- Smartphones
- TV

INTEGRATED
OPERATIONS

LBG Laptops

U Ultrabook



S Entry Ultrabook



Ultra slim

Y Game Player



Z Colorful



G Fighting boxes



Mainstream

YOGA



MIIX



Convertibles

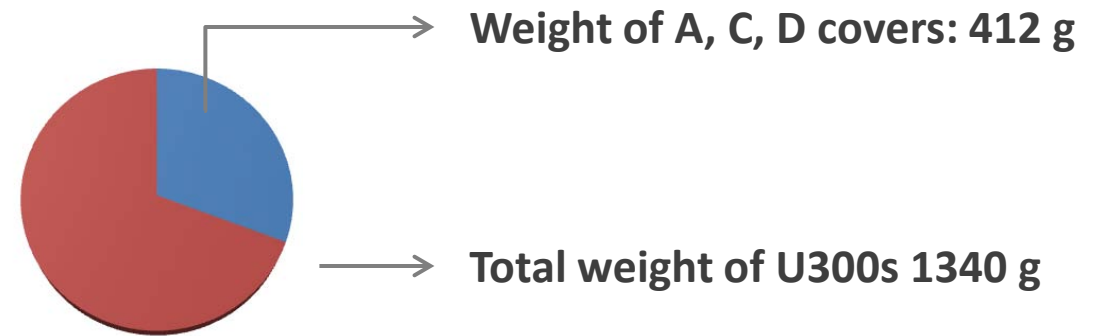
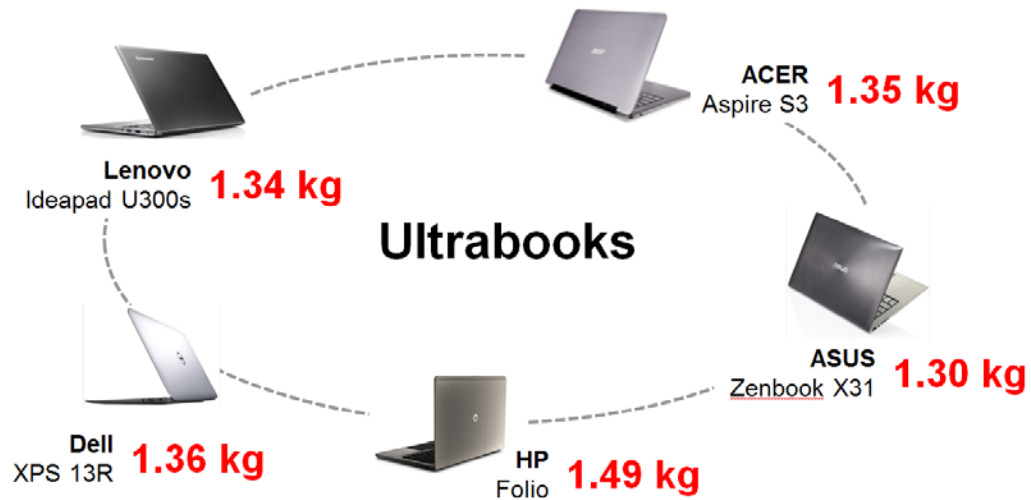
The image features the Lenovo logo in a metallic, three-dimensional font. The logo is centered horizontally and set against a dark, textured background that resembles carbon fiber or a woven composite material. The lighting on the logo creates highlights and shadows, giving it a sense of depth and a sleek, industrial appearance.

CASE Study: Applying Composites as Laptop Enclosures

A red geometric shape, resembling a stylized arrow or a corner piece, pointing towards the right.

PROJECT BACKGROUND

Ultrabooks



- All 1st Gen. Ultrabooks used metallic enclosures (Al-alloy)
- The weight of metallic enclosure is 30%-40% of the total weight of the system.

A bottle of coke ?

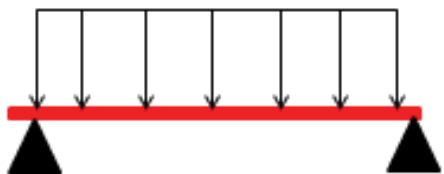
1.35 kg =



Weight reduction is
a must.

Ultralim

Q: Load



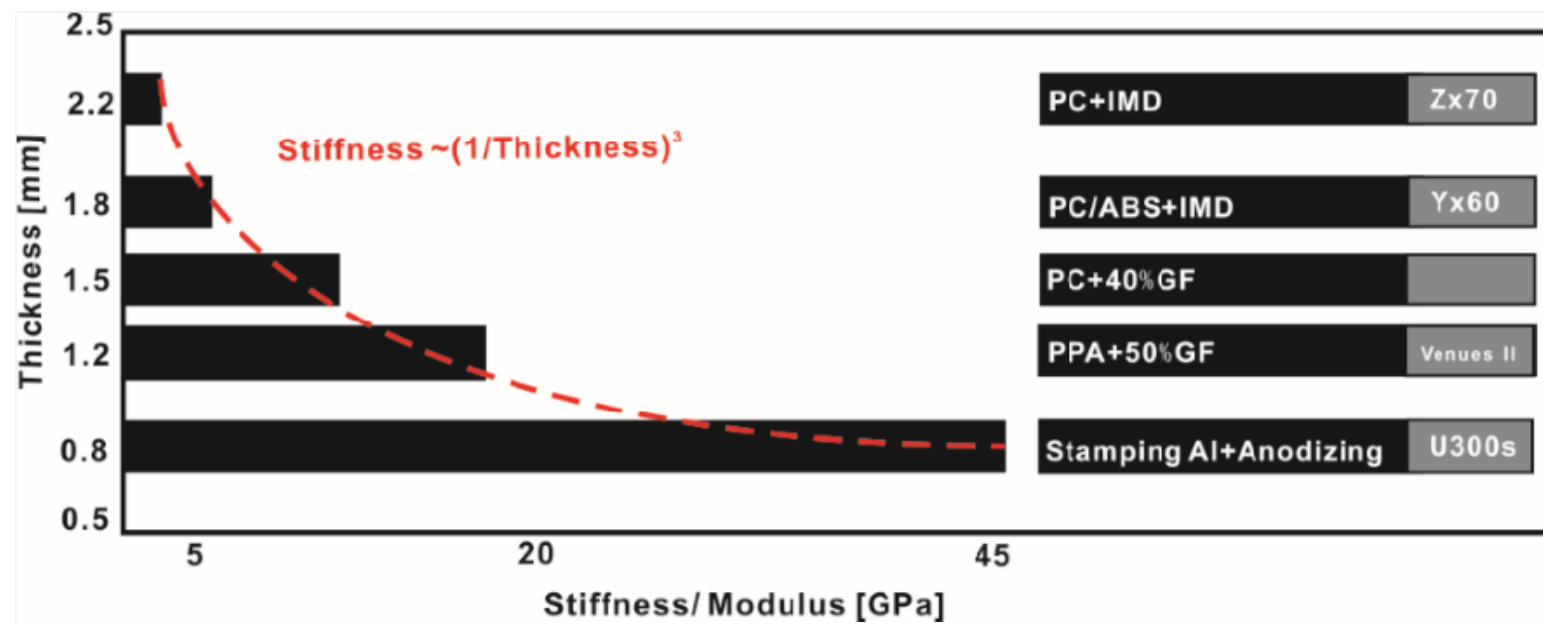
$$f = \frac{5QL^3}{32EBH^3}$$

Length

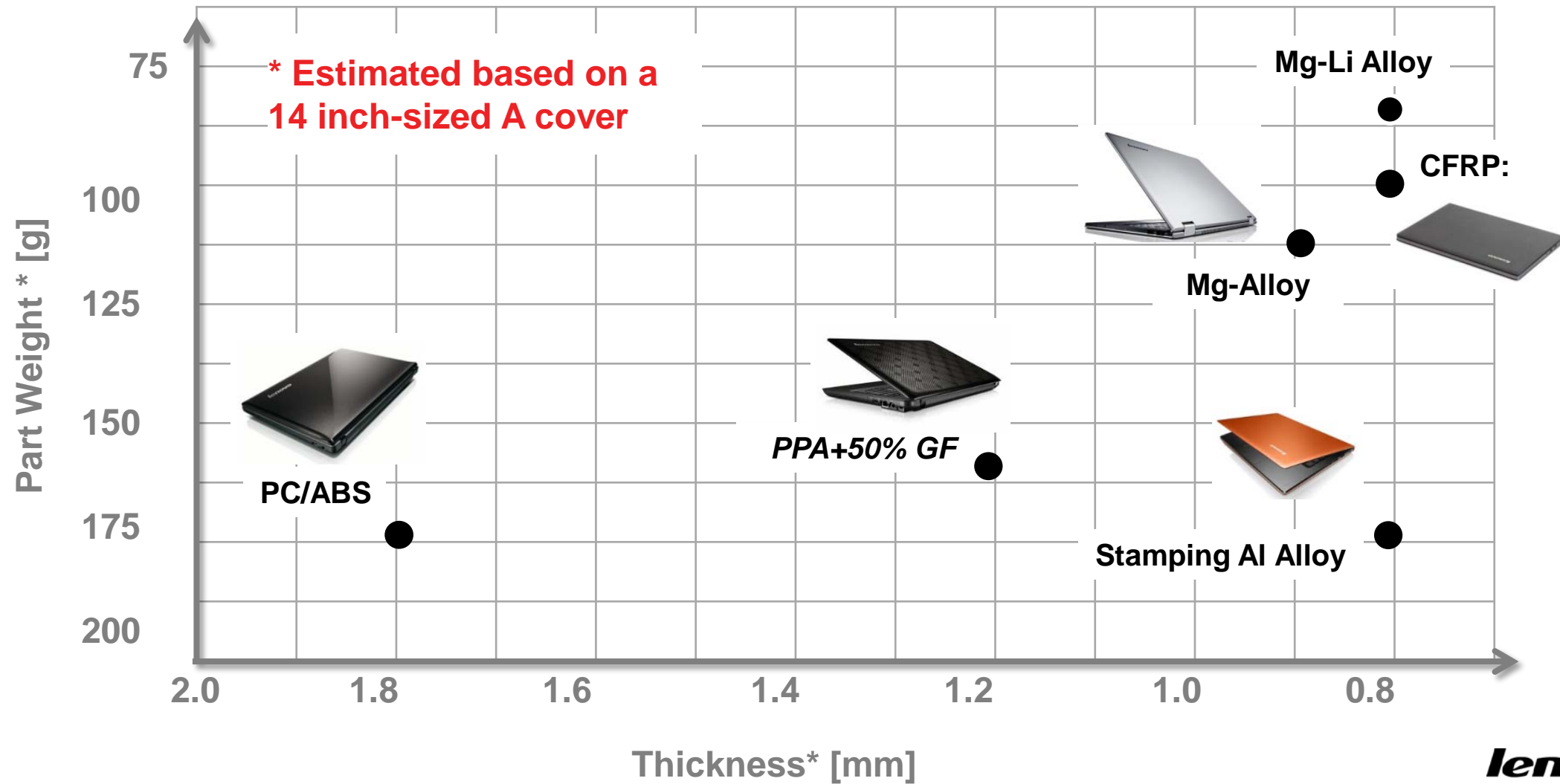
Thickness

Width

Elastic Modulus



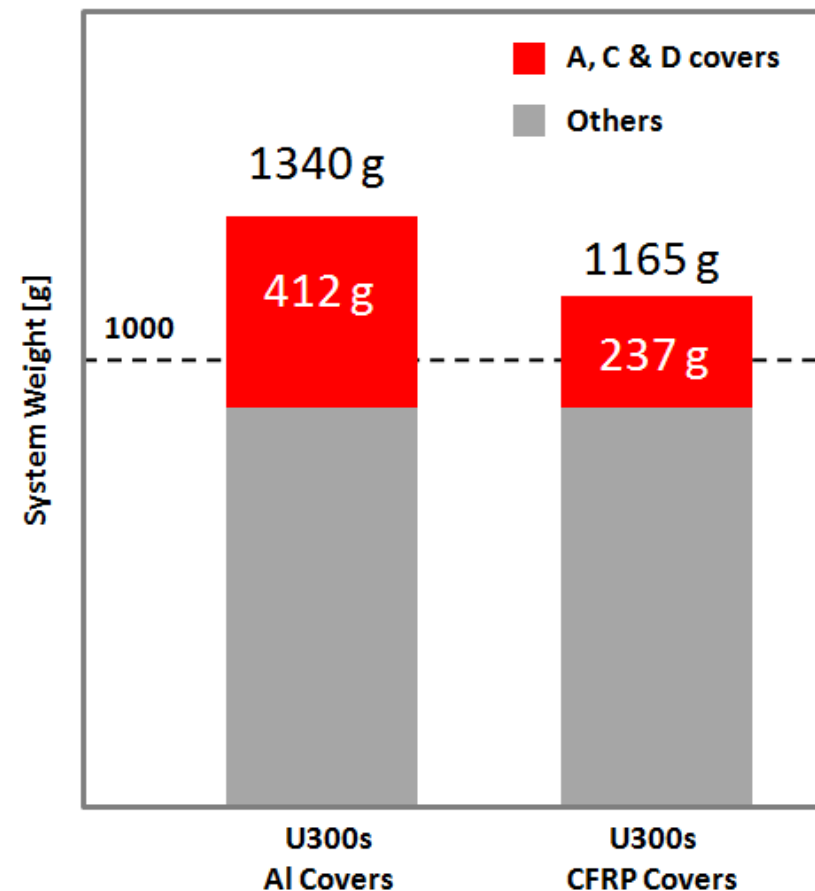
Ultralim ≠ Ultralight



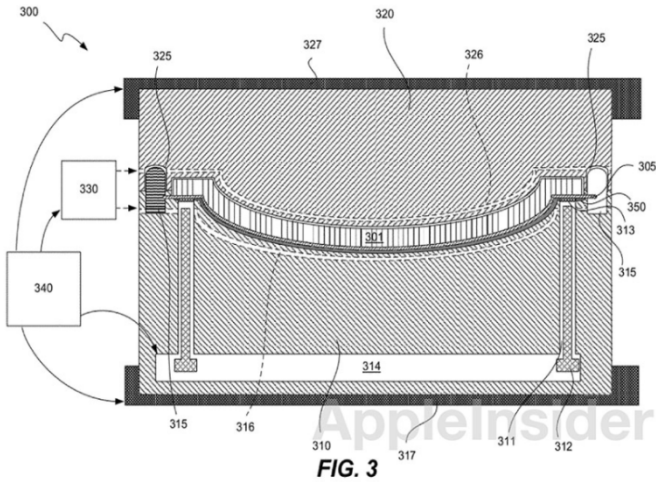
Benefit

Parts	Al Covers [g]	CFRP Covers [g]
LCD Cover	152	97
Top Cover	117	55
Base Cover	143	85
Others	928	928
Total	1340	1165

- Data calculated based on geometry of U300s



Successful Stories

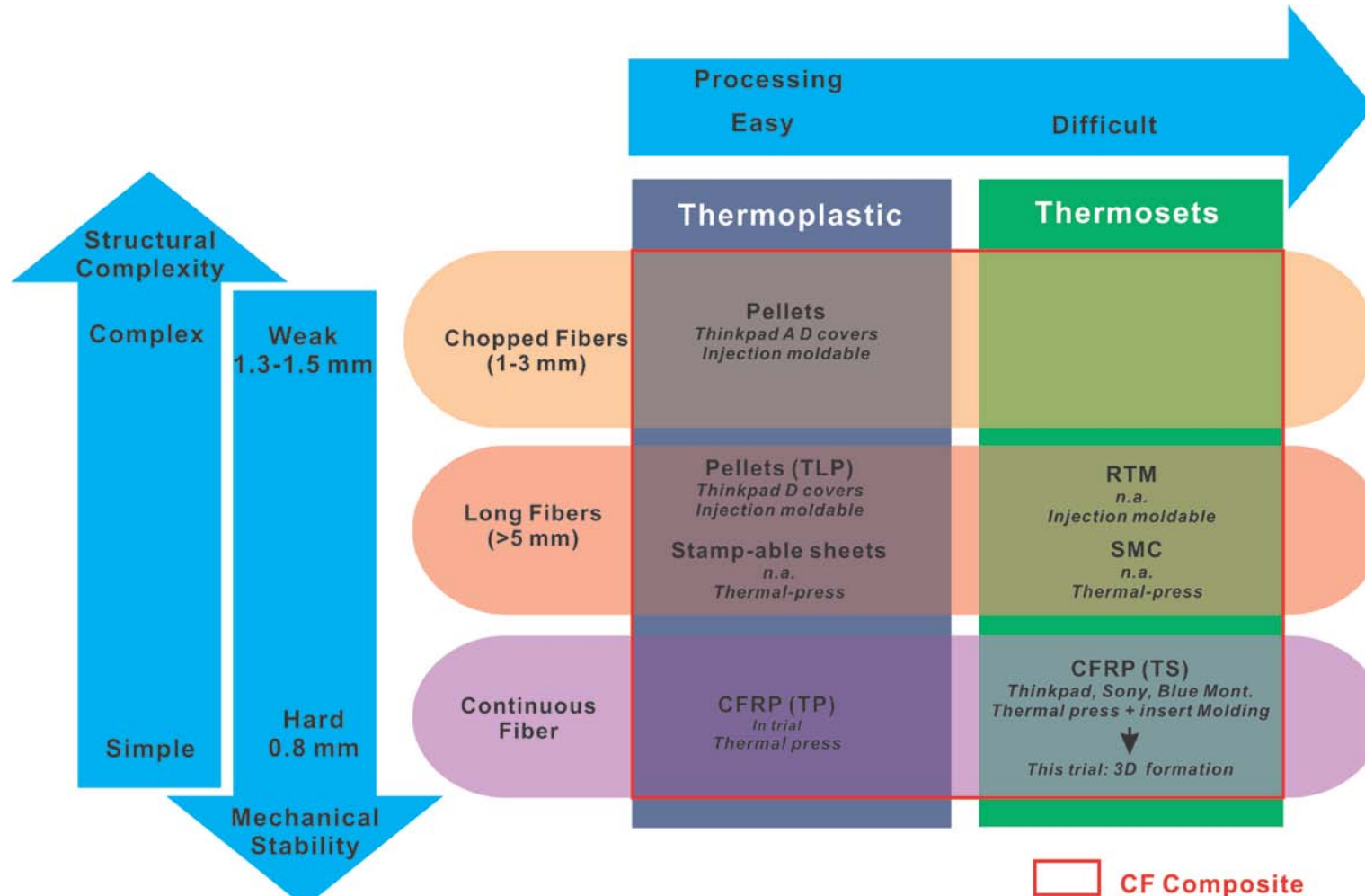


lenovo FOR
THOSE
WHO DO.

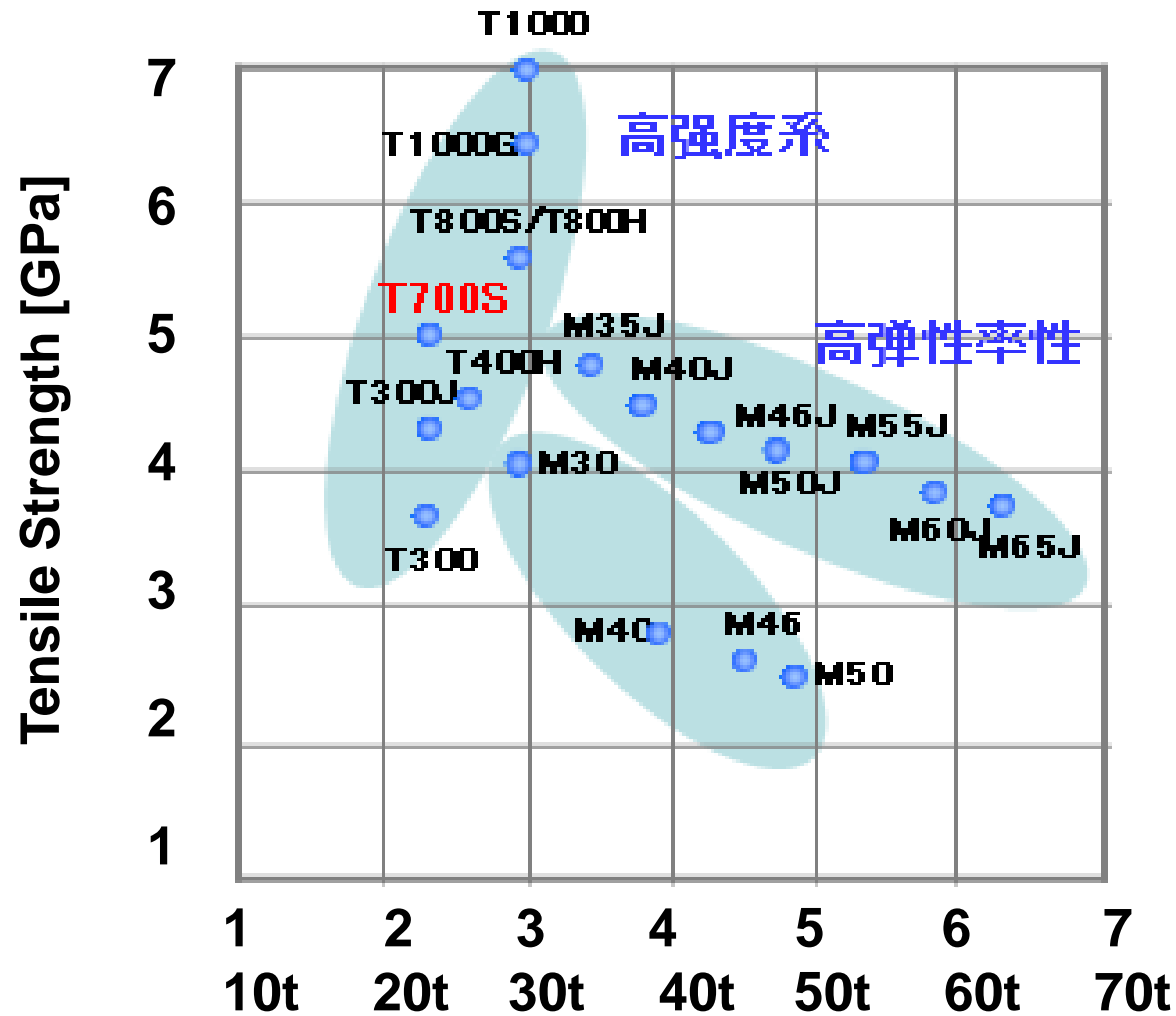
A red geometric shape, resembling a stylized 'L' or a corner piece, is positioned on the left side of the slide. It has a vertical edge on the left and a diagonal edge on the right.

DEVELOPMENT of CFRP PARTS

Material

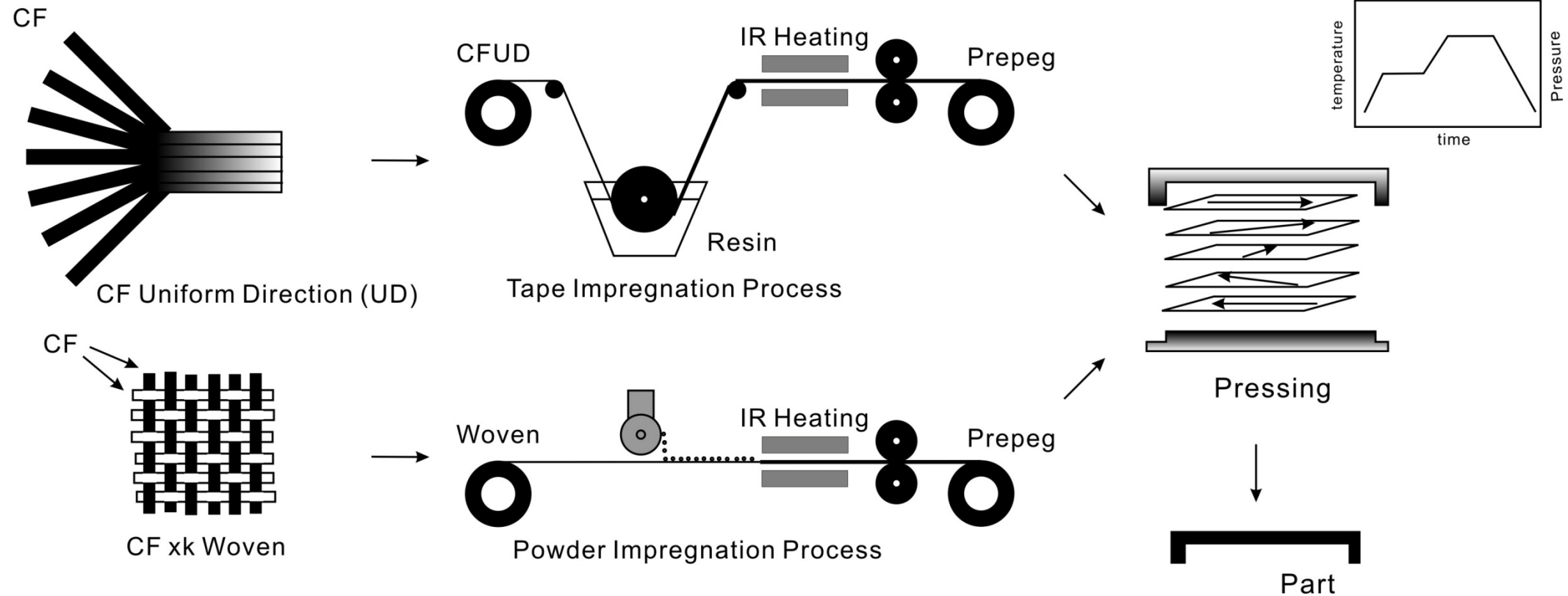


CF Grades

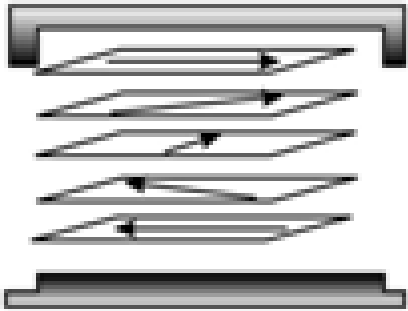


Tensile Modulus [100 GPa]
Commercial grades

Processing of CF Plates (Thermosets)



Isotropic

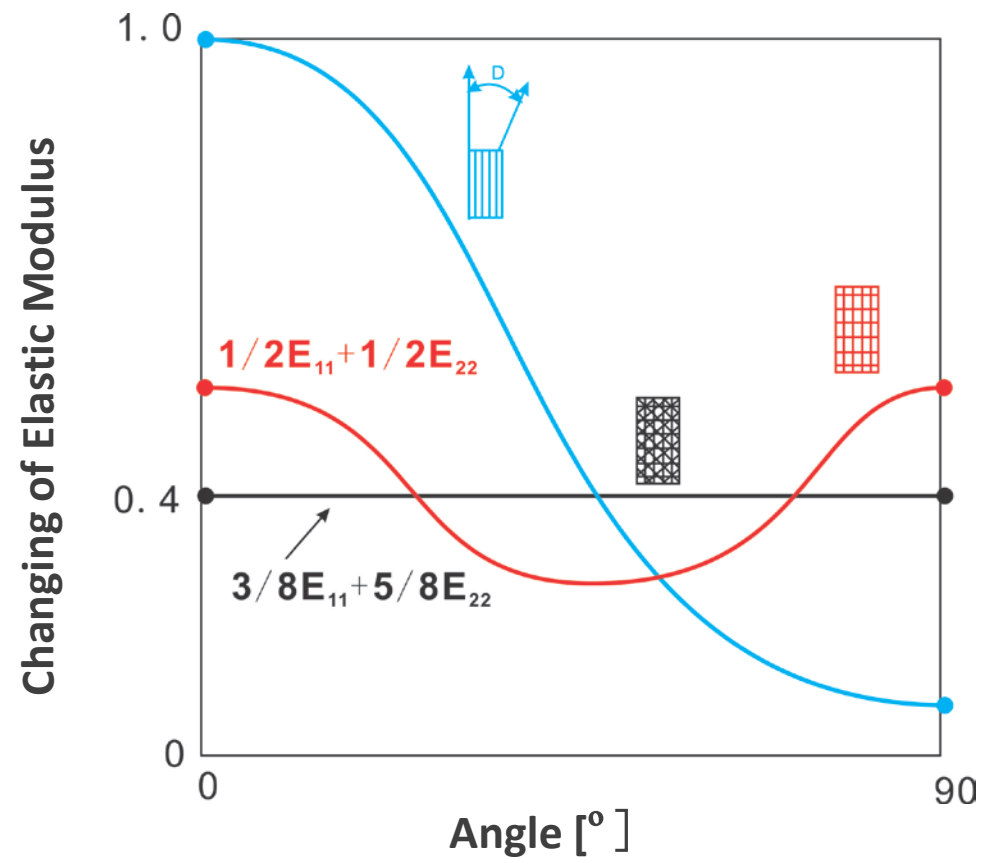


Pressing

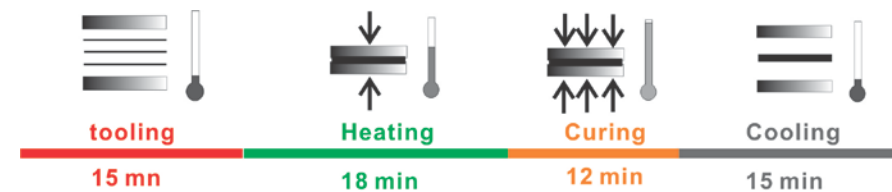
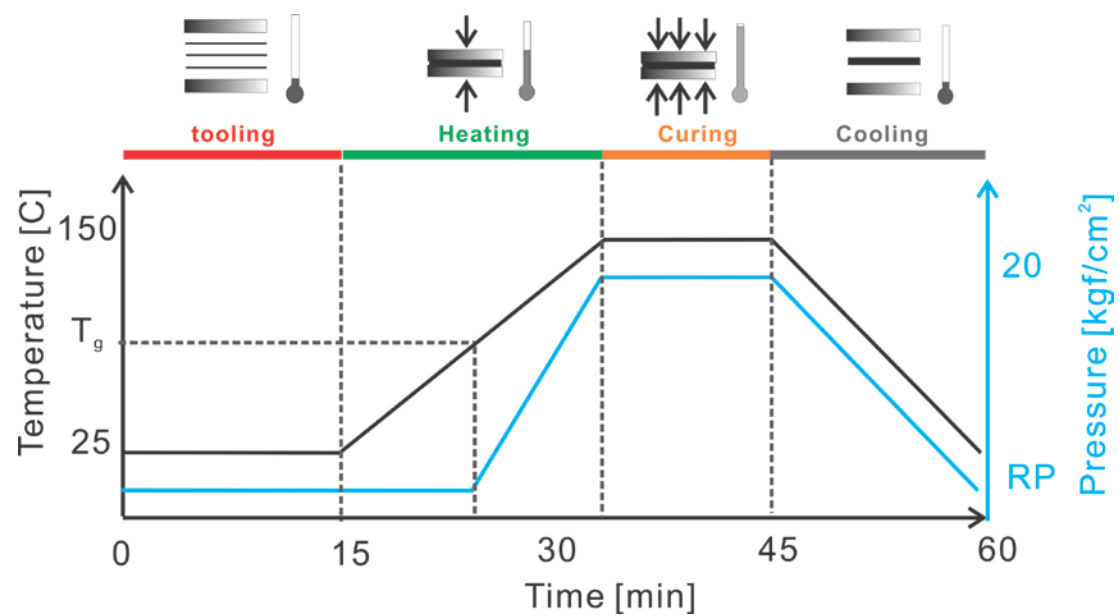
Typical fiber orientation:
0/90/-45/45



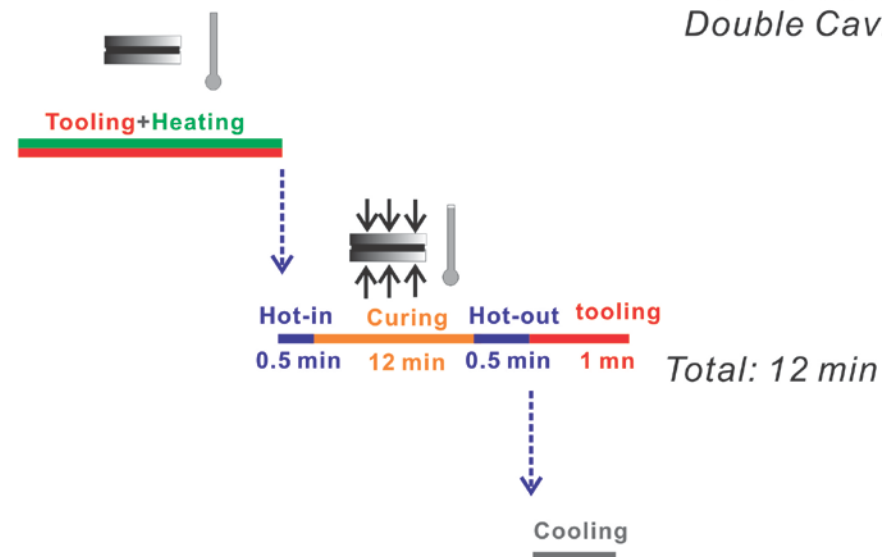
先进复合材料制造技术
(美) 古托夫斯基
化工出版社



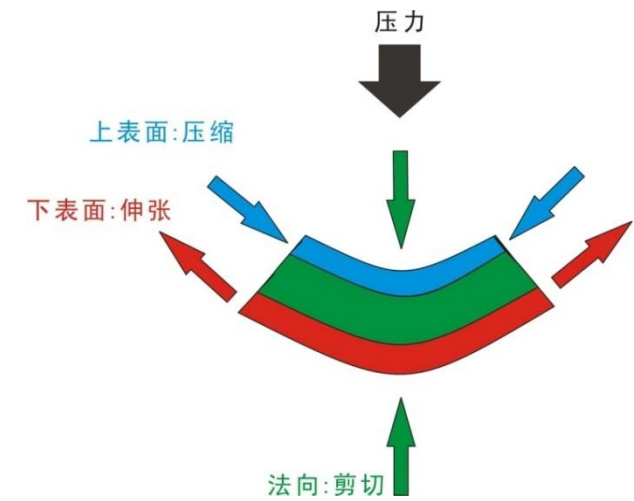
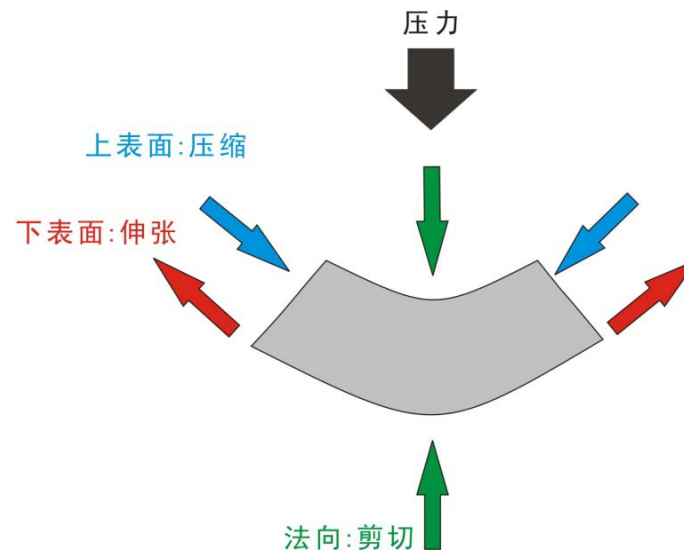
Thermo-pressing



Total: 60 min
Double Cavity: 45 min

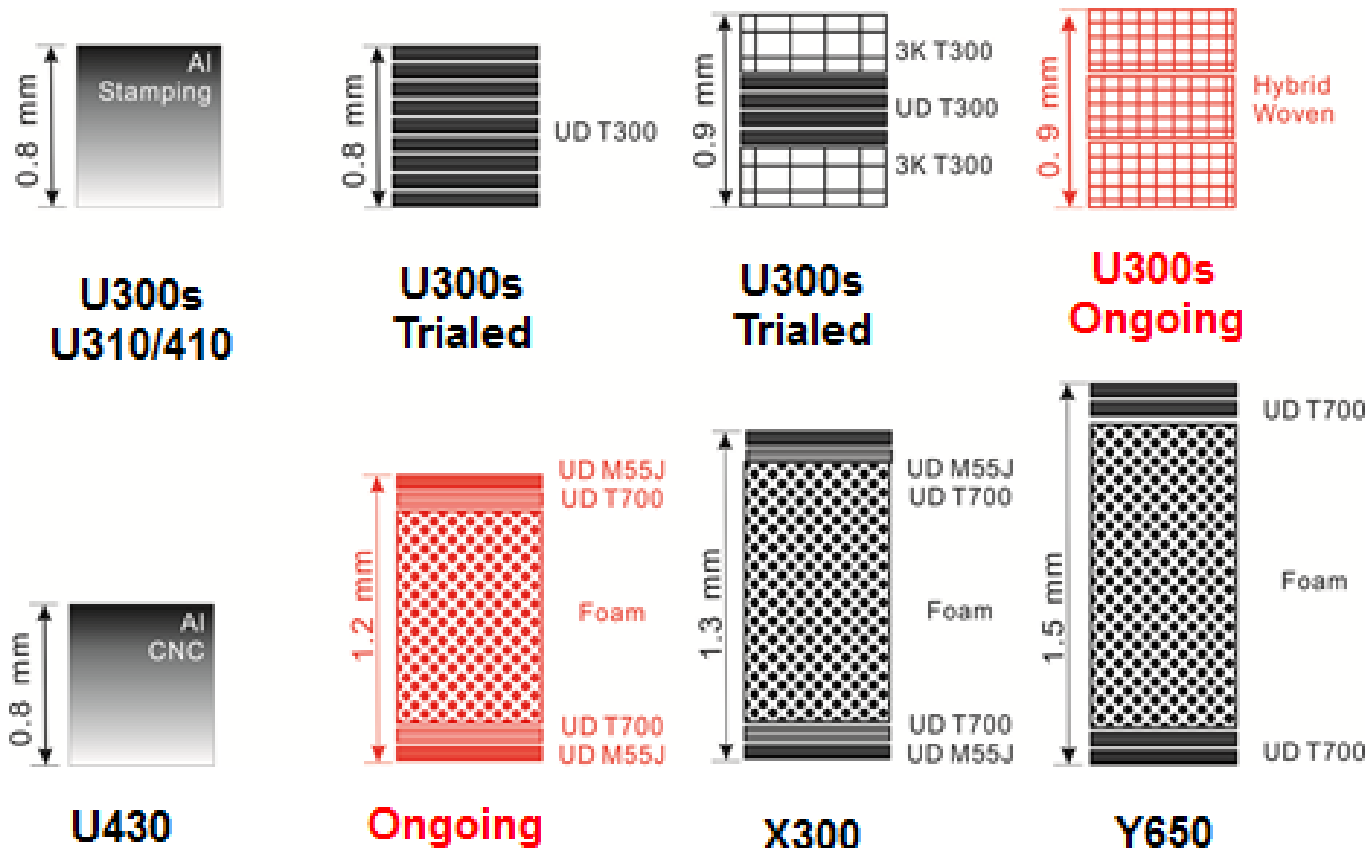


Sandwiches



Development Strategy

Mechanical Stable



R&D Portfolio 1: 3D Stamping

CTQ:

- Appearance
- Cost
- Antenna

R&D Portfolio 2: Insert Molding

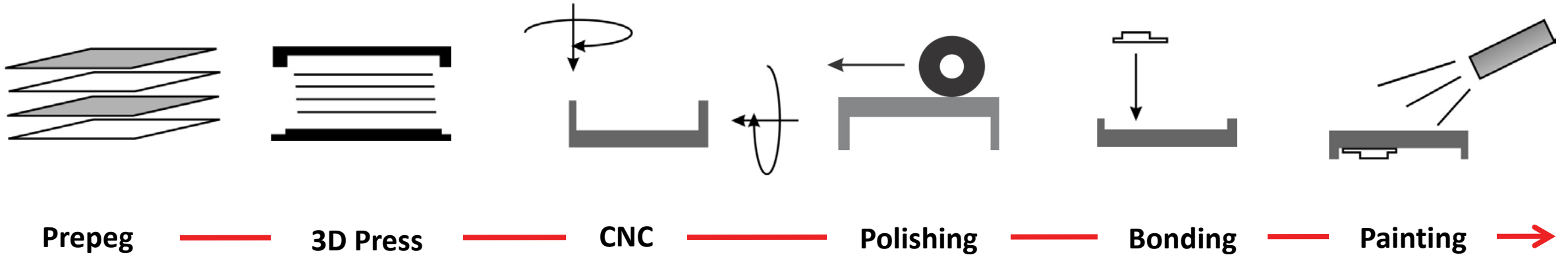
CTQ:

- Performance
- Flexibility

A red geometric shape, resembling a stylized 'P' or a folded corner, is positioned on the left side of the slide.

PRACTICAL EXPERIENCES

3D + bonding



Advantage:

- High Efficiency
- Unique surface appearance, no knit-lines
- Good match to ID design
- Relative low part cost

Disadvantage:

- Bonding strength,
- Assembling tolerance
- Solution to antenna performance
- Aging at edges
- No chance for sandwich structure

Prototype

Prototype: U300s

March. 2012



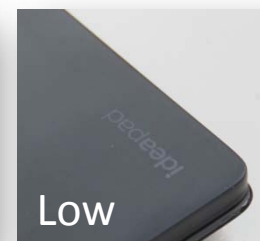
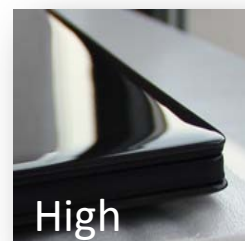
Dimension	Dimension stability [%]	+ 0.5-1
	Z-direction <u>warpage</u> [mm]	0.3-0.5
	Undercuts	Not recommended
	KB frame / thermal vents	Not recommended
Processing	Mini. Radii	R 0.5
	Mini. Side wall-thickness for [mm]	1.2
	Mini. Hole diameter [mm]	0.15
	Mini. Hole edge distance [mm]	2
	Recess in-depth [mm]	0.35

Features

Appearance



Glossy



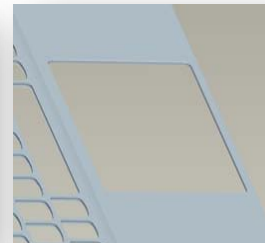
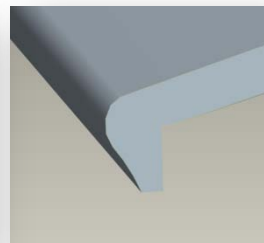
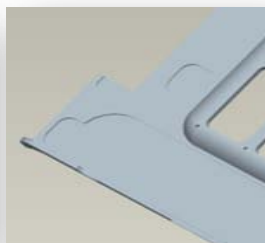
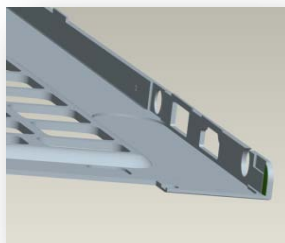
Patterns



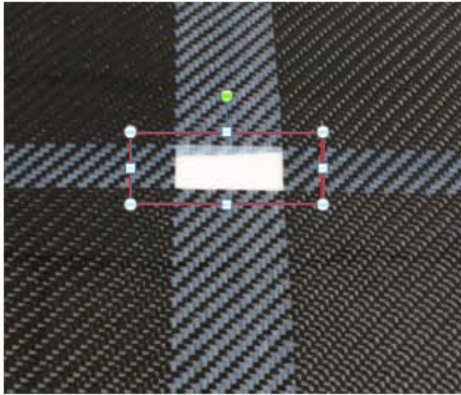
Logo



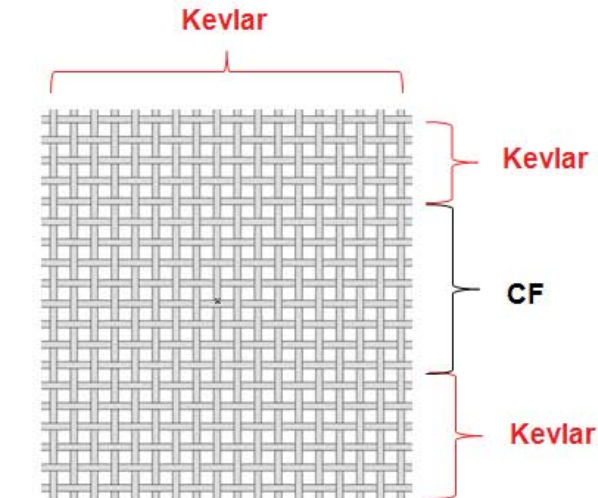
3D Features



ID Design & Antenna Solution

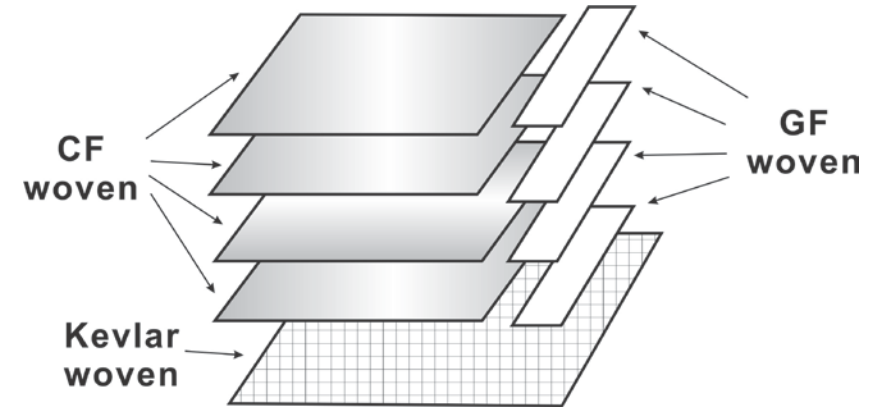


Gen. 1 CF/GF Woven



Gen. 2 Kevlar/CF Woven

Haoning & Youdt Patent Disclosure

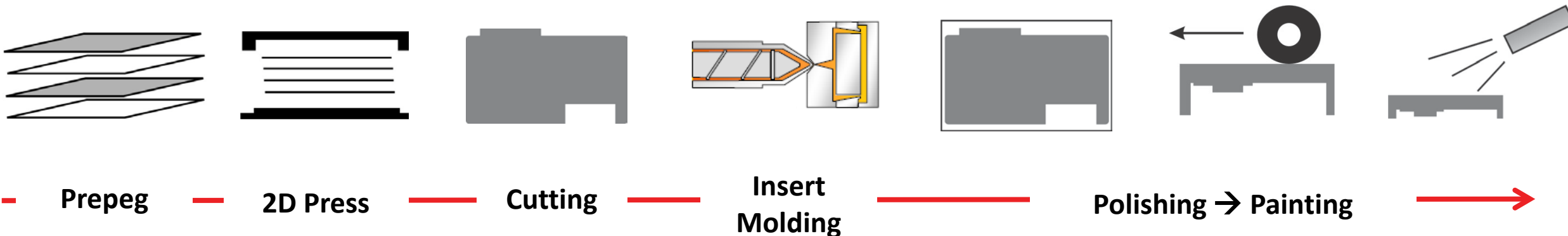


Hybrid thermo-pressing

Haoning & Youdt Patent Disclosure

Risks: High Cost | Appearance & Color Difference

2D + Insert Molding



Advantage:

- Solution to Antenna
- Cover all edges with plastic
- Able to apply sandwich structure
- Good assembling performance
- Good assembling strength

Disadvantage:

- Design flexibility
- Knitline
- Technology complexity
- Limited resources
- High processing costs

Insert Molding

Tooling and Processing

- Tooling design
- Tooling costs
- Design of conjunction
- Clamping system/logo
- Cooling system

Design Details

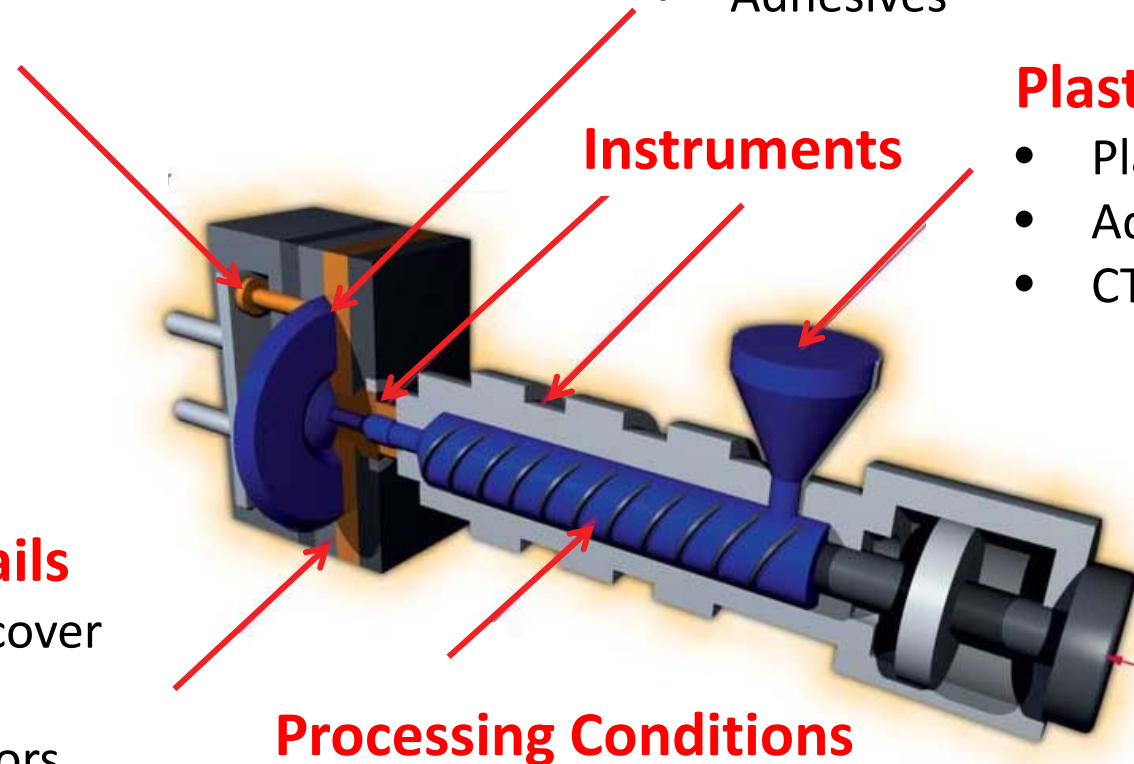
- Antenna cover
- Coating
- Form factors
- Appearance

CFRP

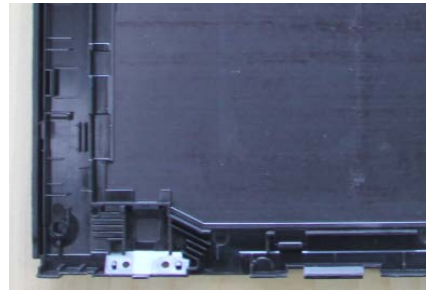
- CFRP Stiffness/thickness contr.
- Foams
- Adhesives

Plastic

- Plastic Material
- Adhesion
- CTE



Current Progress



Gen. 1

- Non-transparent coating
- Thermosets
- Sandwich. d=1.5 mm
- Antenna solution
- \$ 29

Gen. 2

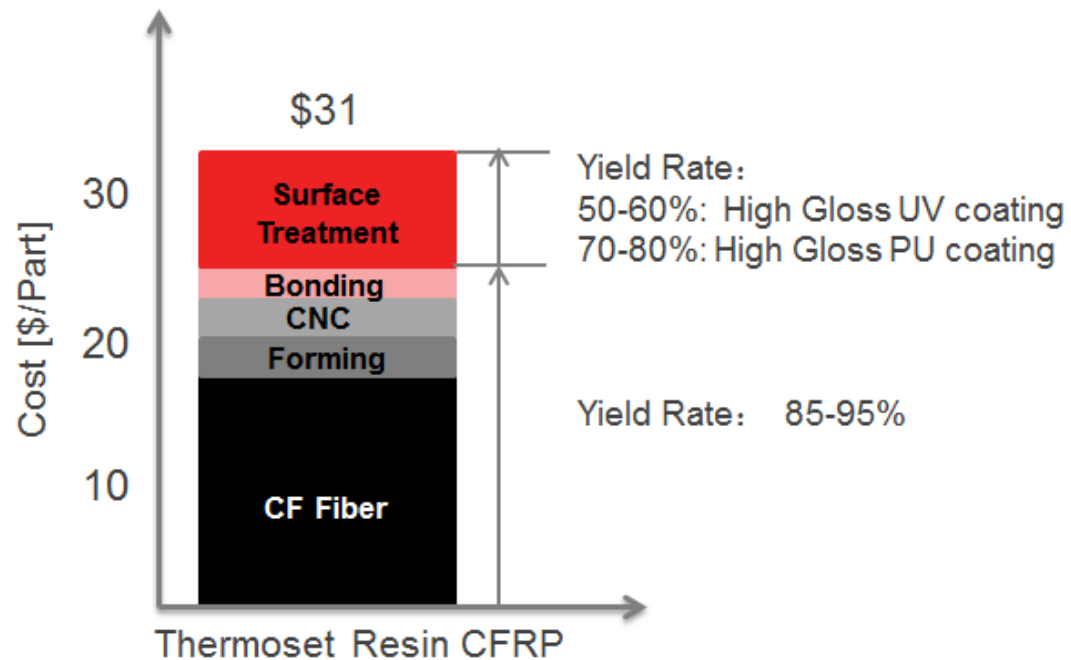
- Transparent coating
- Thermoplastics
- Sandwich. d=1.3 mm
- Antenna solution
- \$ 35

Gen. 3

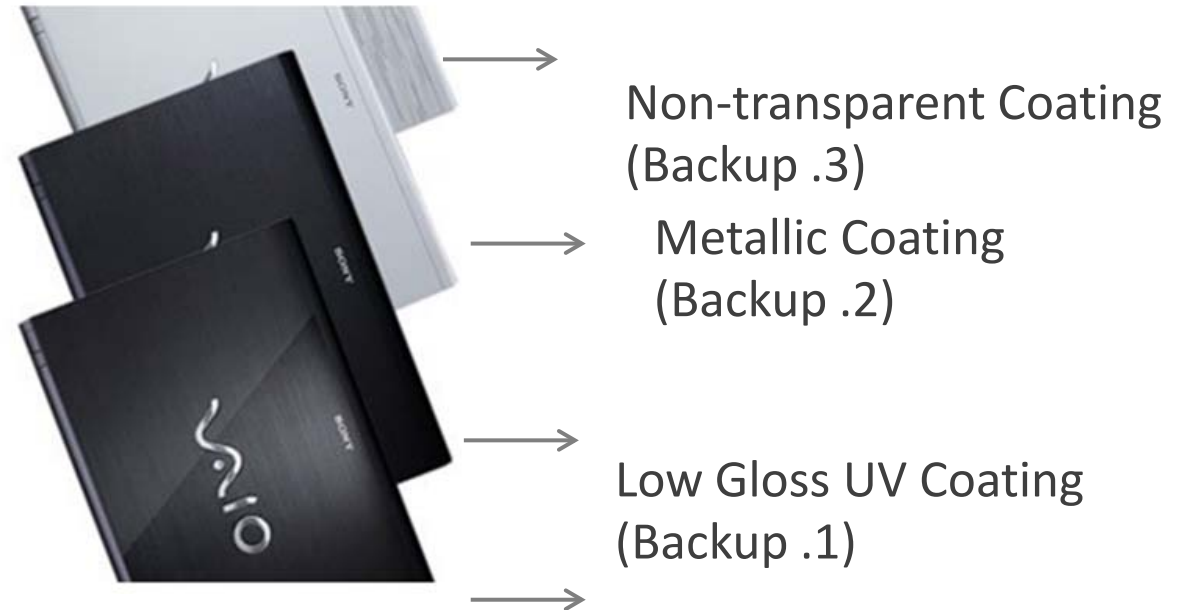
- Transparent coating
- d=1.0 mm
- \$ 25

Gen. 4

Decoration



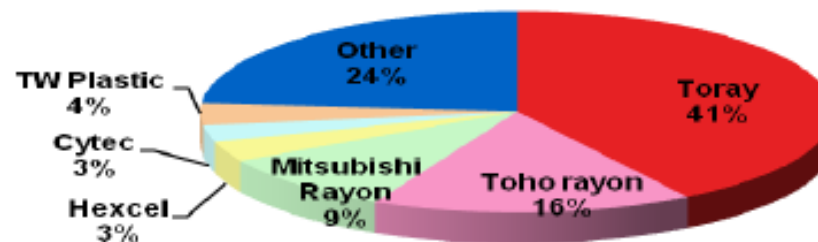
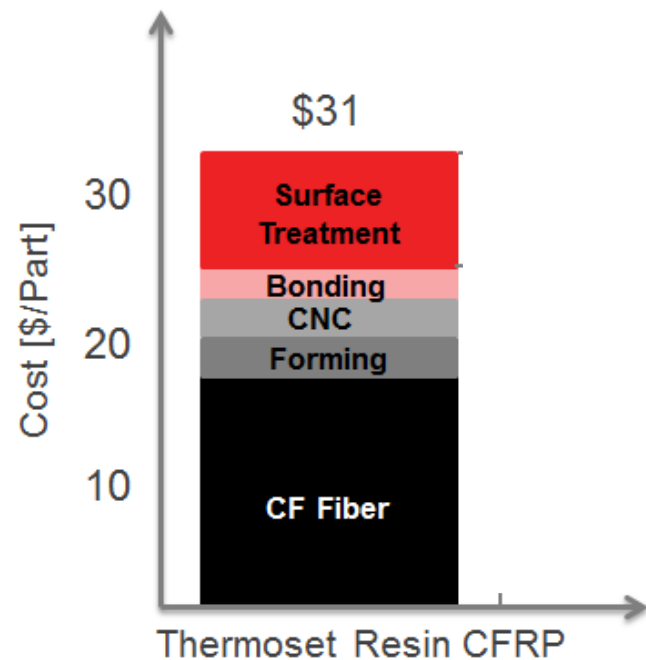
- Using CFRP significantly reduced system weight
- ~ \$10 was spent for surface treatment



A red geometric shape, resembling a stylized 'P' or a folded corner, is positioned on the left side of the slide.

Open Discussions

CF and Continuous Sheet Processing



Cost Target

Material & Processing	Mg-Diecasting	CFRP
Thickness	0.8 mm	0.8 mm
Density	1.7-1.8 g/cm3	1.7-1.8 g /cm3
Antenna Performance	Insert Molding	Insert Molding
Internal Features	Insert Molding	Insert Molding
General Decoration Method	Painting	Painting
Appearance	Plastic – like	Premium
Resources	Mainland China	?
Cost Estimated	USD 17-20	?

Summary



THANK YOU **GRAZIE** **MERCI** **DANKE** **GRAZIAS** 謝謝 **СПАСИБО**
GRACIAS **OBRIGADO** ありがとう **DANK** **TAKK** **BEDANKT** **DAKUJEM**