Electromagnetic Shielding of Plastic Packaging in Cost-Effective Optical Transceiver Modules

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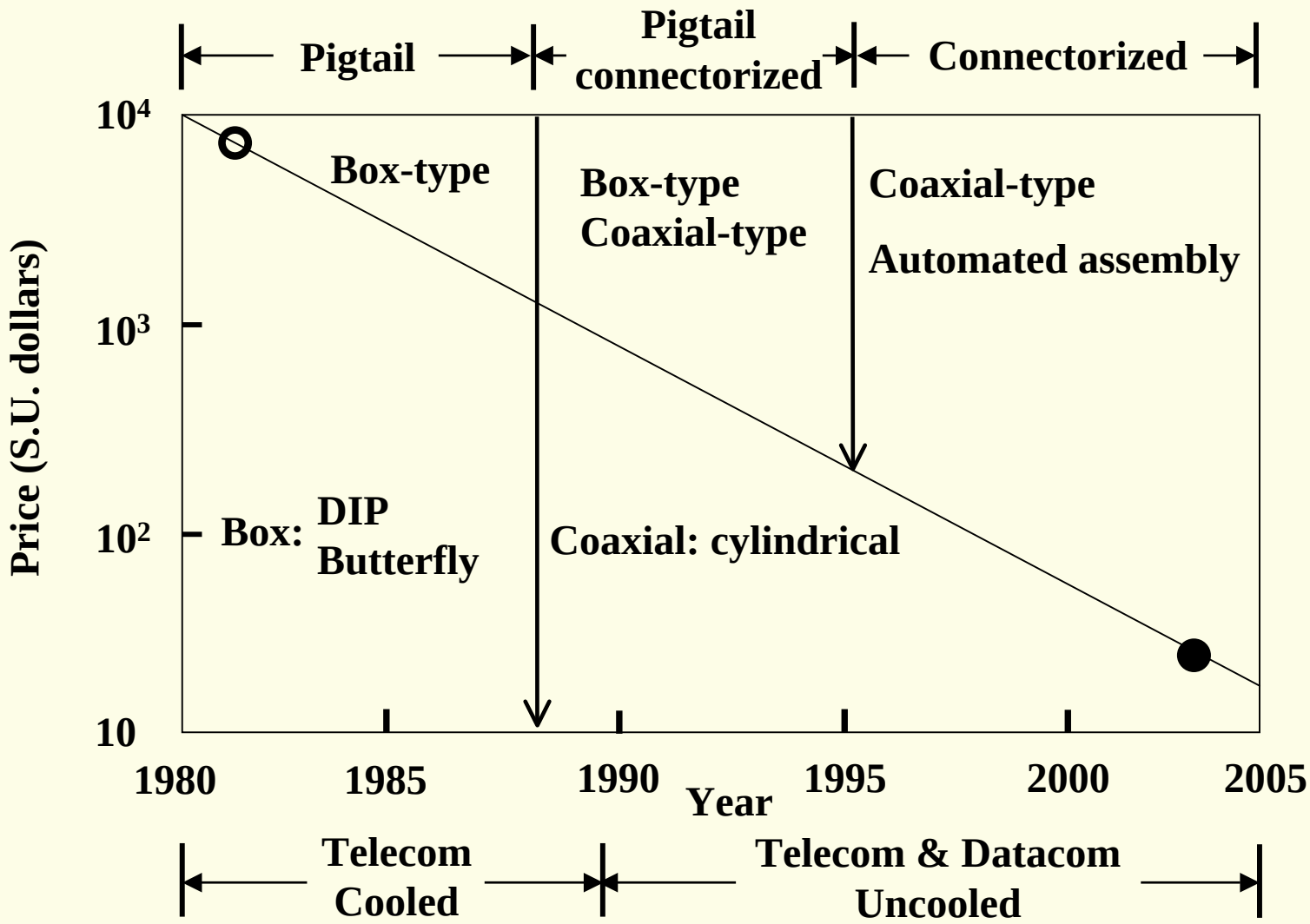
Objective of Study

To develop the plastic optical transceiver modules with low cost and low electromagnetic interference (EMI) for use in Gigabit Ethernet or fiber to the home (FTTH) lightwave communication systems

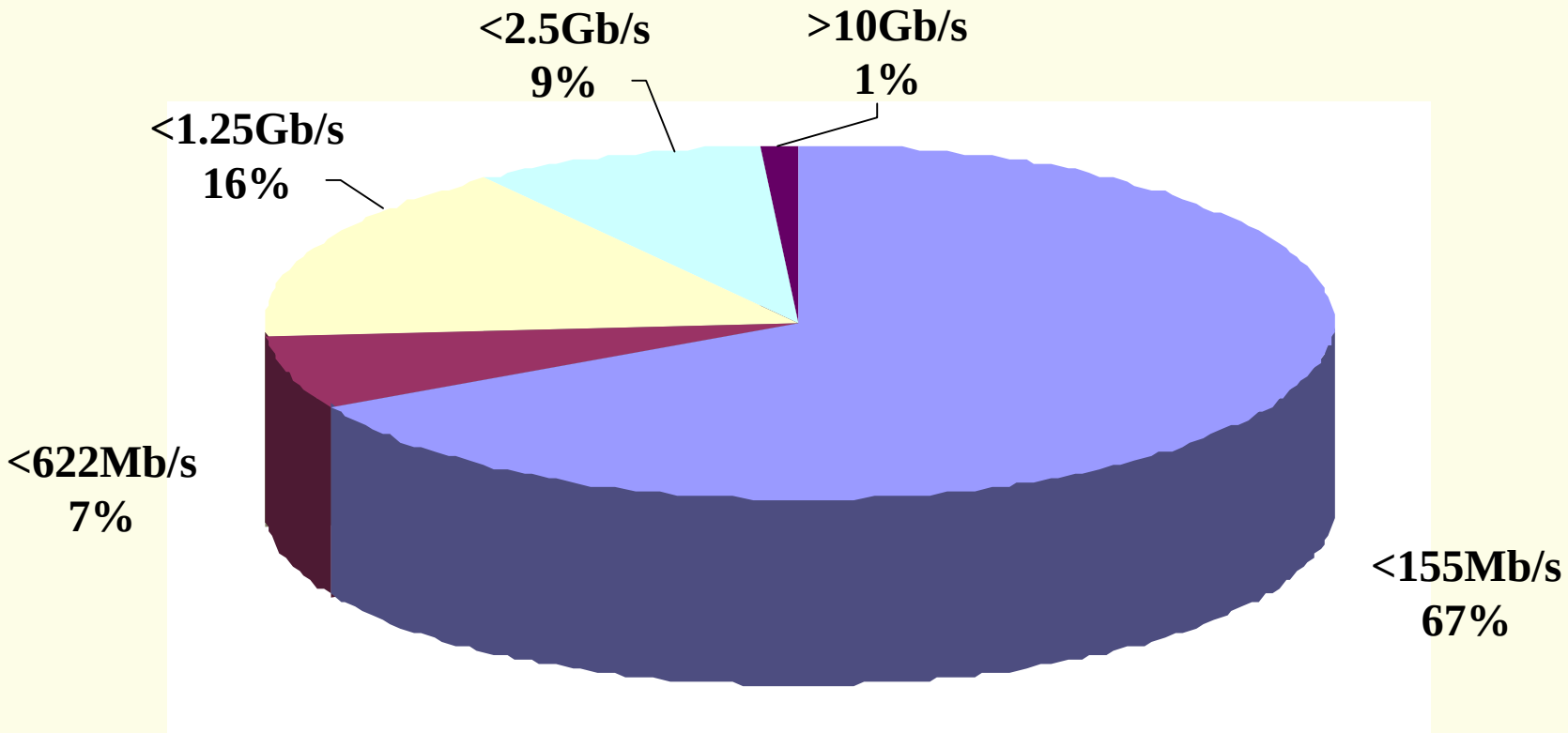
Outline

1. **Motivation**
2. **Fabrication and Shielding Performance of Plastic Composites with Discontinuous Carbon Fiber Fillers**
3. **Fabrication and Shielding Performance of Plastic Composites with Continuous Carbon Fibers**
4. **Fabrication and Shielding Performance of Hallow Carbon Nanocapules**
5. **Comparison of Fabrication and Shielding Performance for Plastic Composites and Plastic Optical Transceiver Modules**
6. **Conclusion**

Low Cost Laser Module Packages



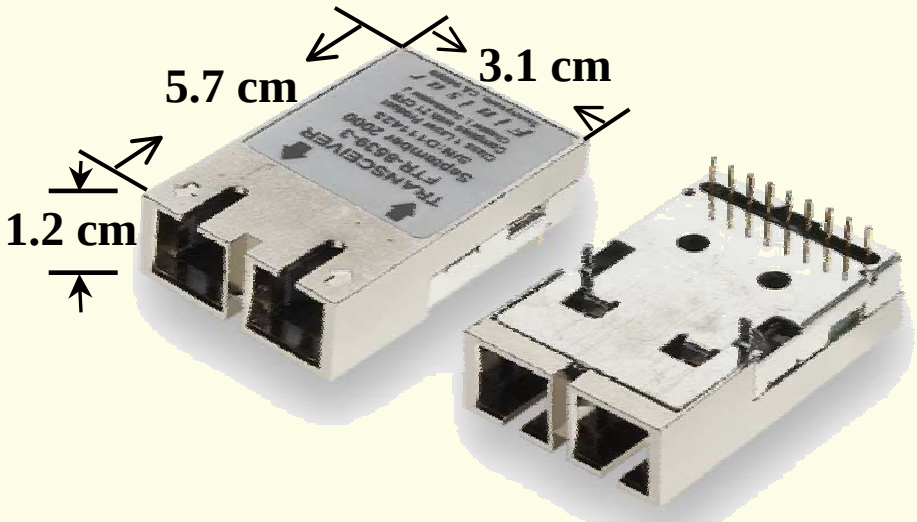
Transceiver Module Market



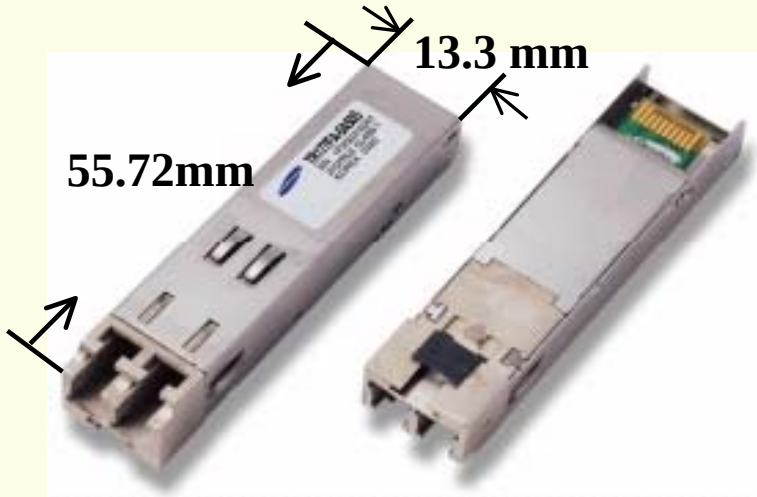
Source: Fuji Chimera (2002)

Optical Transceiver Module

Data Rate :155Mb/s ➔ 1.25Gb/s ➔ 2.5Gb/s



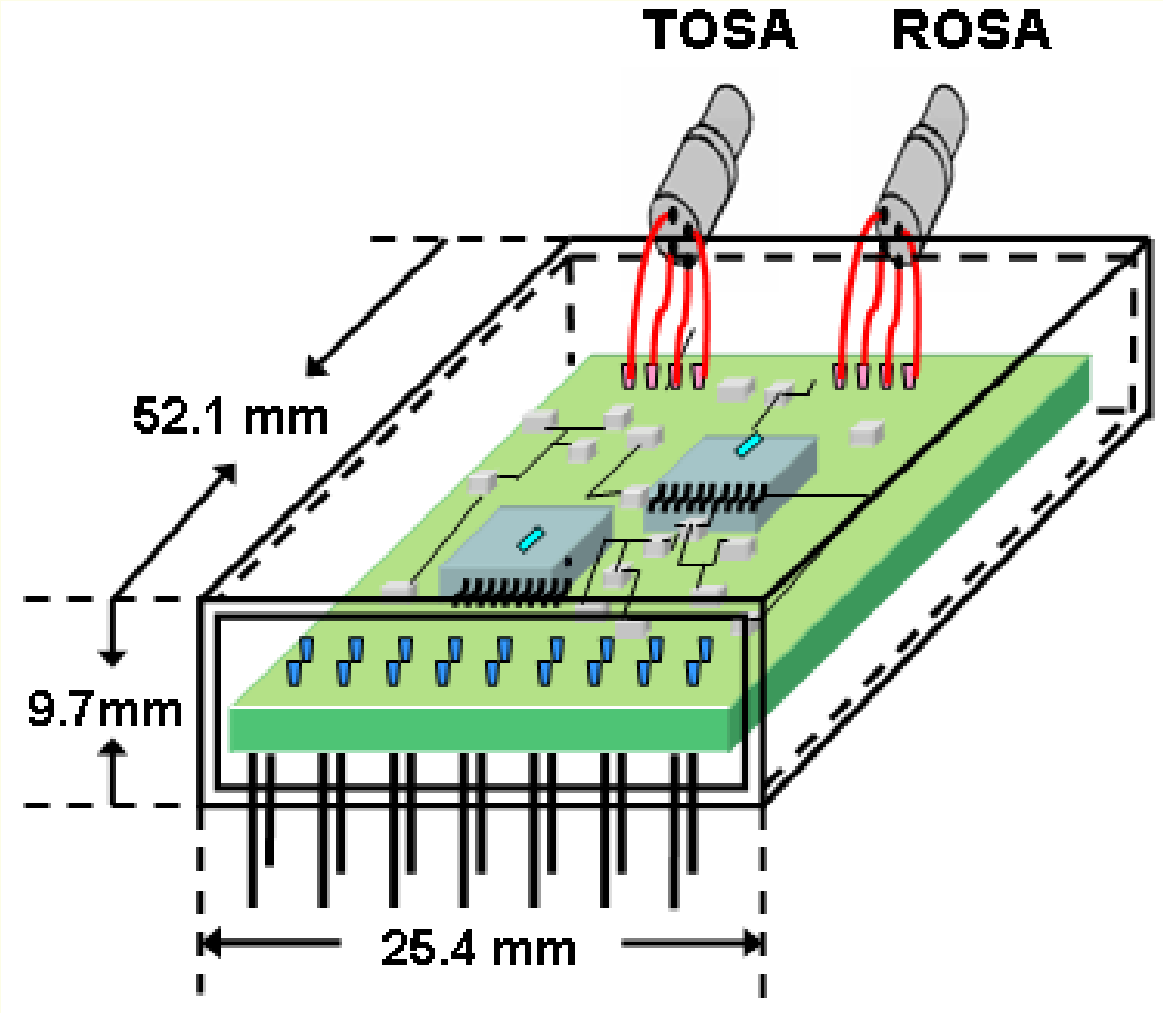
1X9 Type



Height = 8.55 mm

Small Form Factor Pluggable (SFP)

Frame of Transceiver Module



Techniques for plastic EM shielding

- Conductive sprays
- Conductive fillers
- Zinc-arc spraying
- Electro-plating or electrolysis-plating on housing surfaces
- Modifications of electrical properties during the molding stage
- Metallization processes

Conductive fillers for EM shielding

- Metal particles
- Metal flakes
- Stainless fiber
- Graphitized carbon particles
- Graphitized carbon fibers
- Metal-coated glass
- Carbon fibers

Fabrication of plastic composites

1.Twin–Screw Extruder

Process:

Plastic materials

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Carbon fibers

↓

Plastic composites

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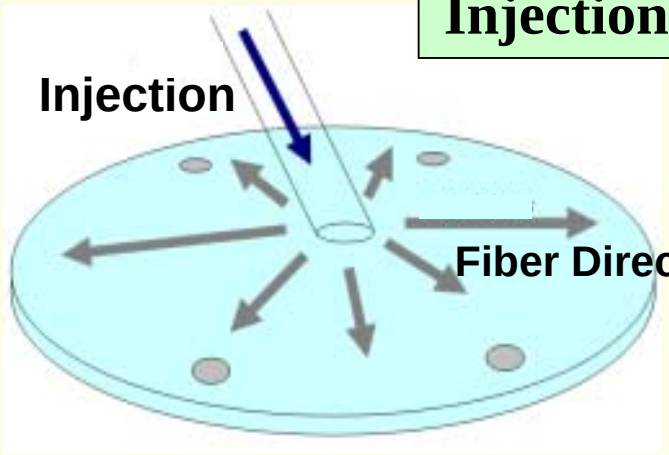
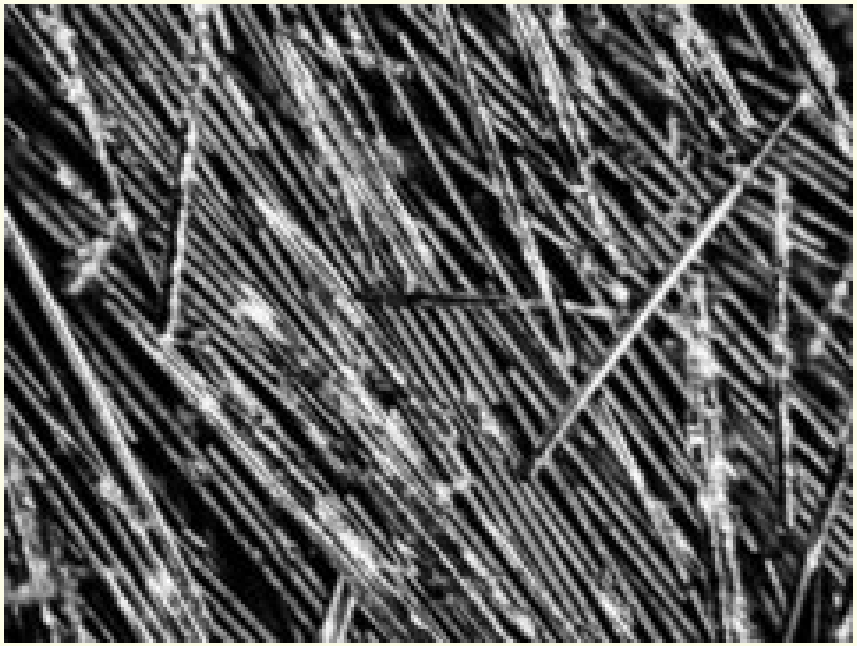
Injection Molding

2.Injection-Molded Machine



3.specimen

Metallographic



LCP :

➔with 25% carbon fiber

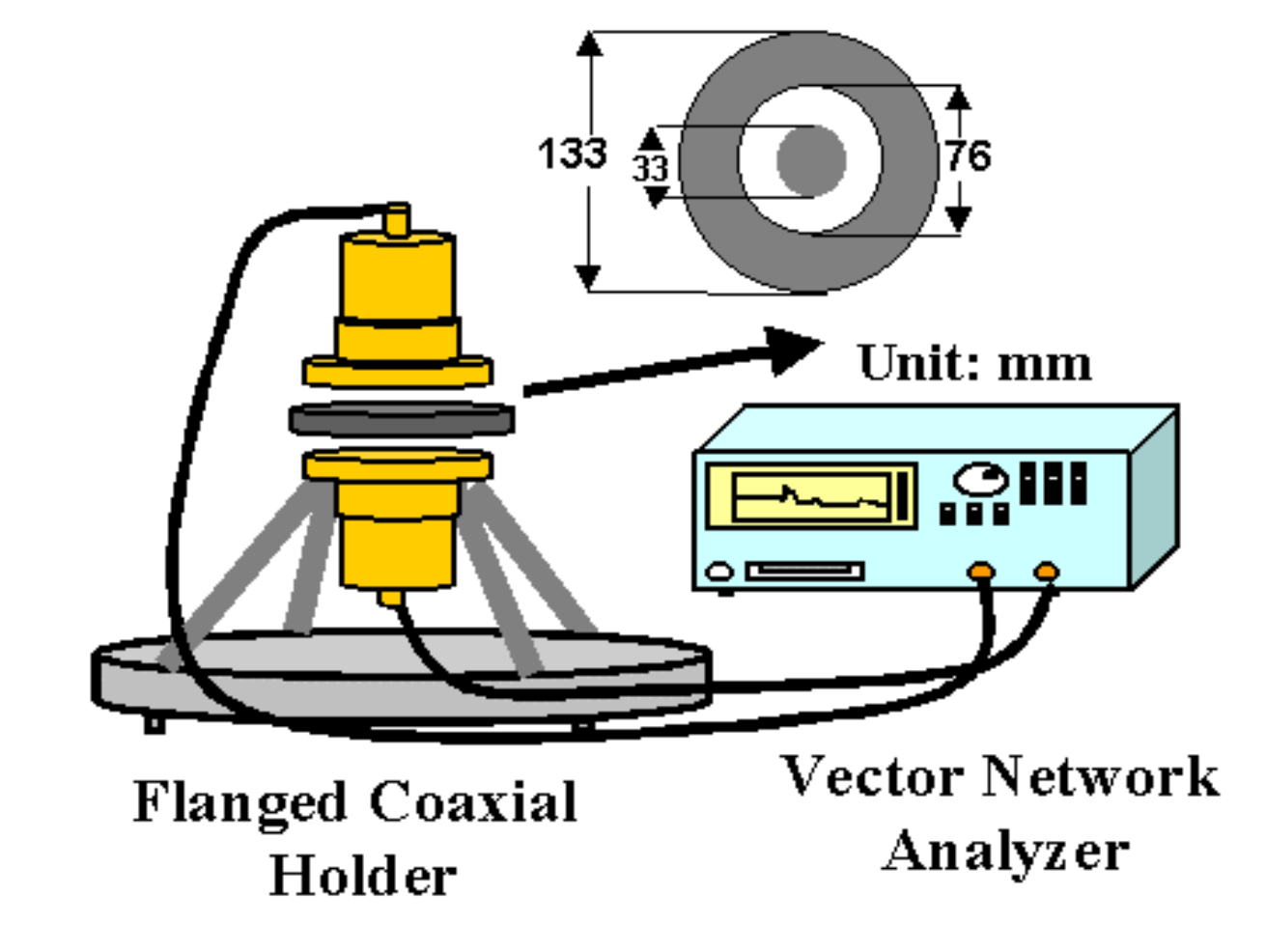
➔orientation uniform

Nylon :

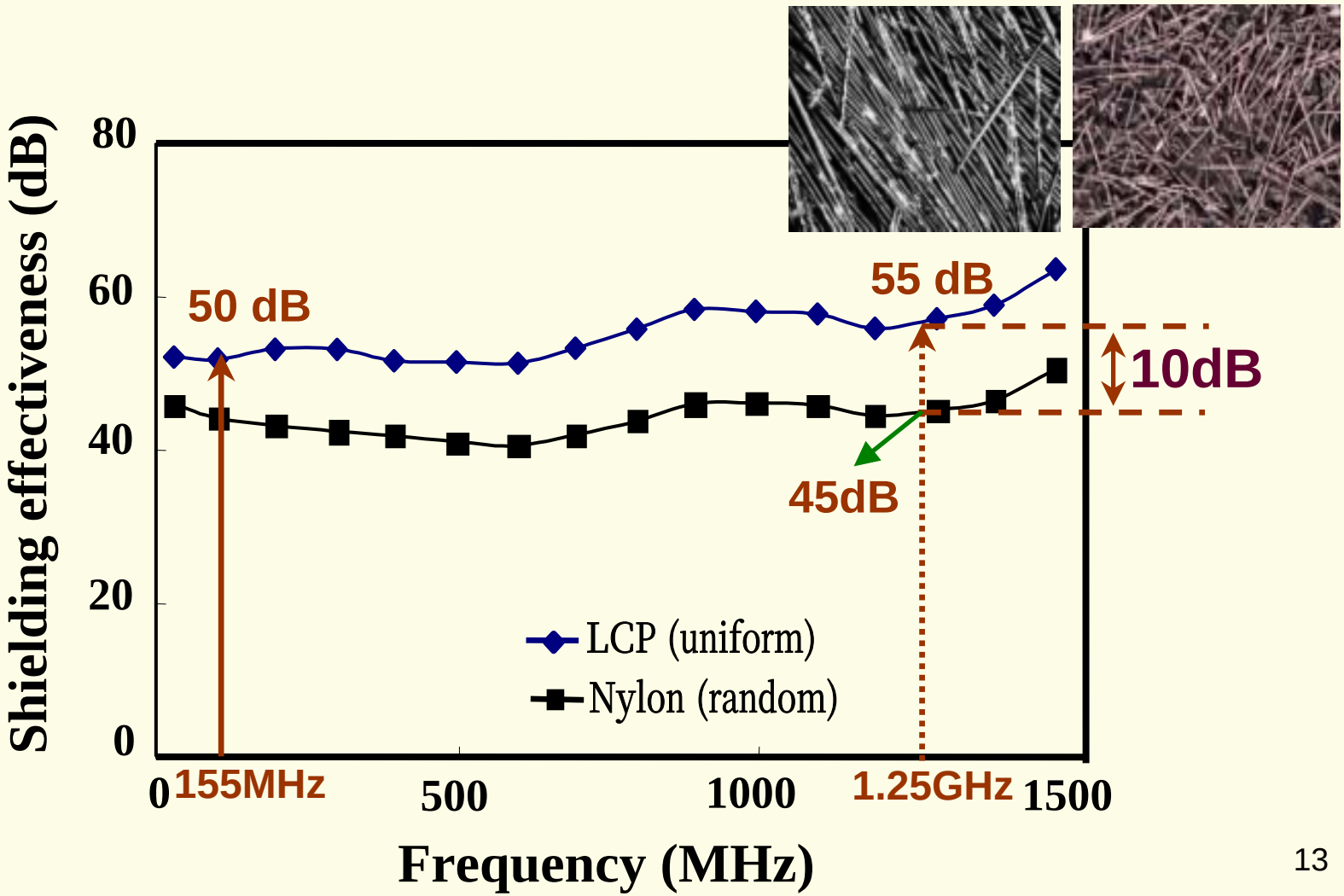
➔with 25% carbon fiber

➔orientation random

Measurement Setup



LCP and Nylon Composites

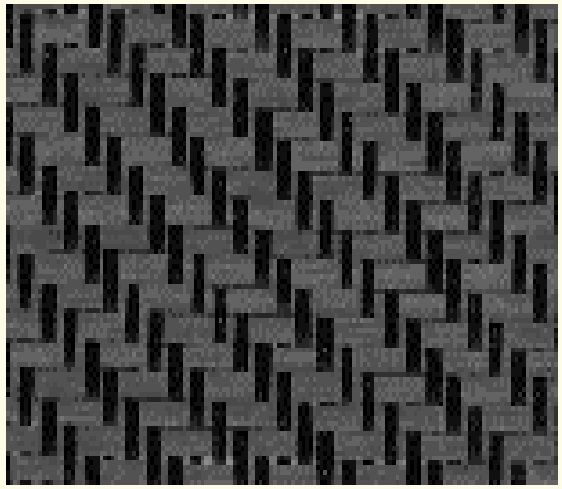


Woven Continuous Carbon Fiber Fabrics

Advantages：

1. **continuous carbon fiber**
2. **complete conductive networks**
3. **easy fabrication and low cost**

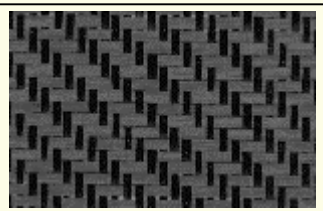
Polymer composites



Fabrics

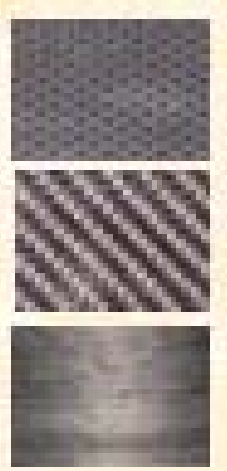
Fabrication of WCC Fabrics

Different Weave Methods



→

Epoxy



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Compression molding machine

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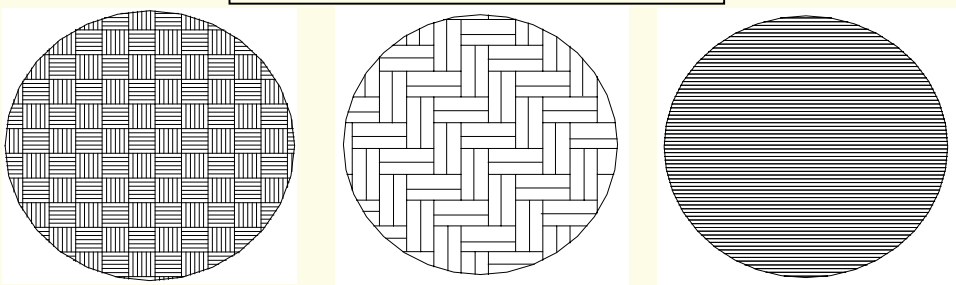
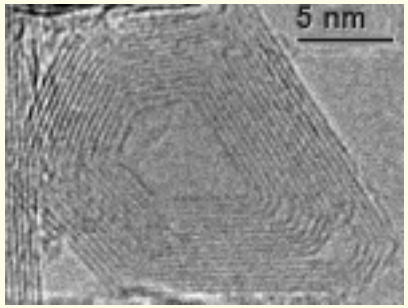
Test samples



Plain **Balanced Twill** **Uni-direction**

Fabrication of HCNCs Composites

HCNCs → **Epoxy**



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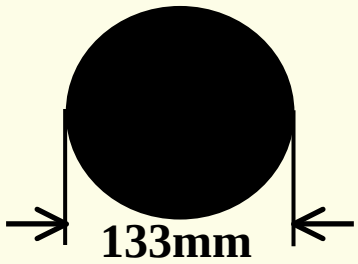
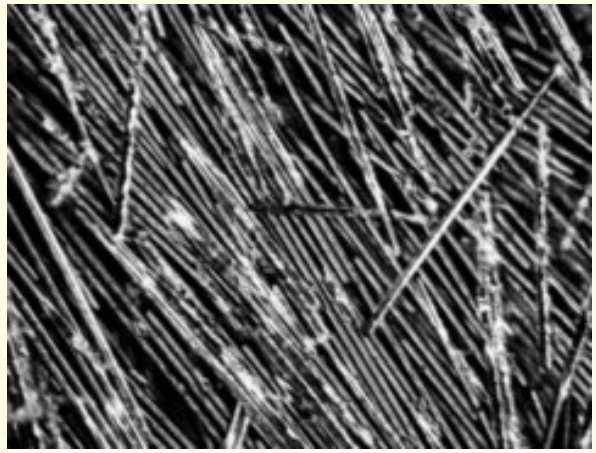
Hydraulic machine → **Test samples**

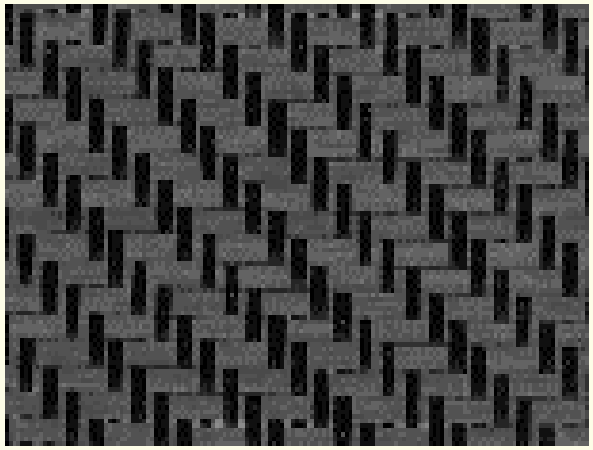


Metallographic

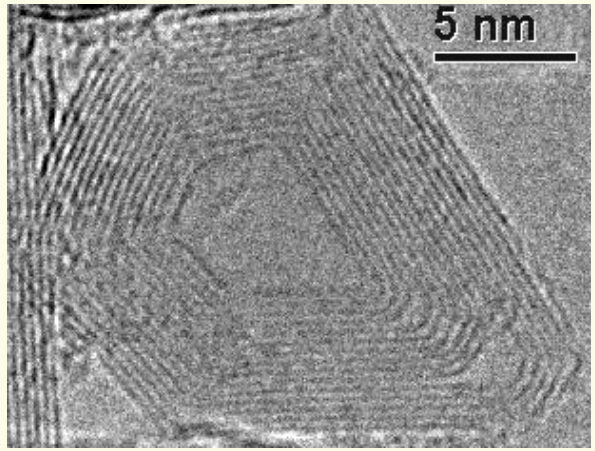
(a) Nylon



(b) LCP

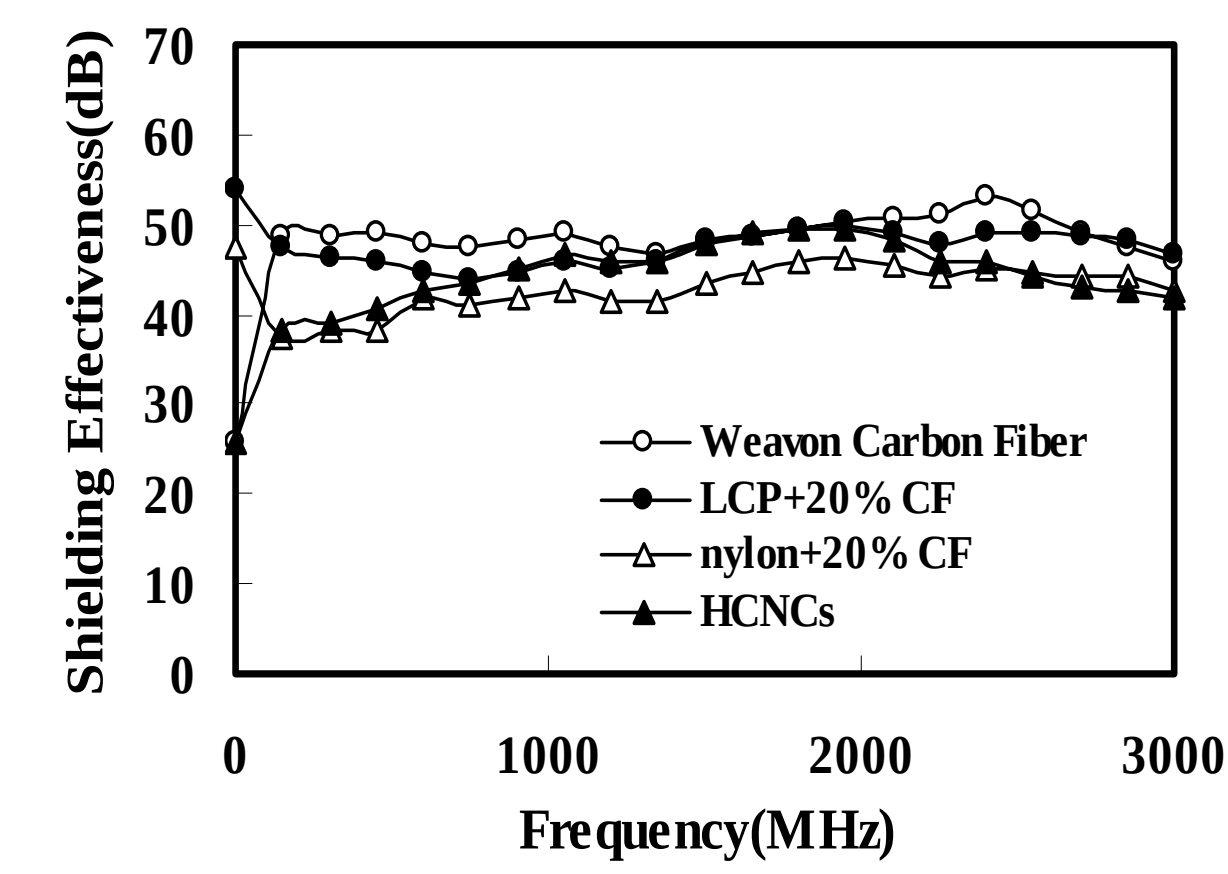


(c) WCCF

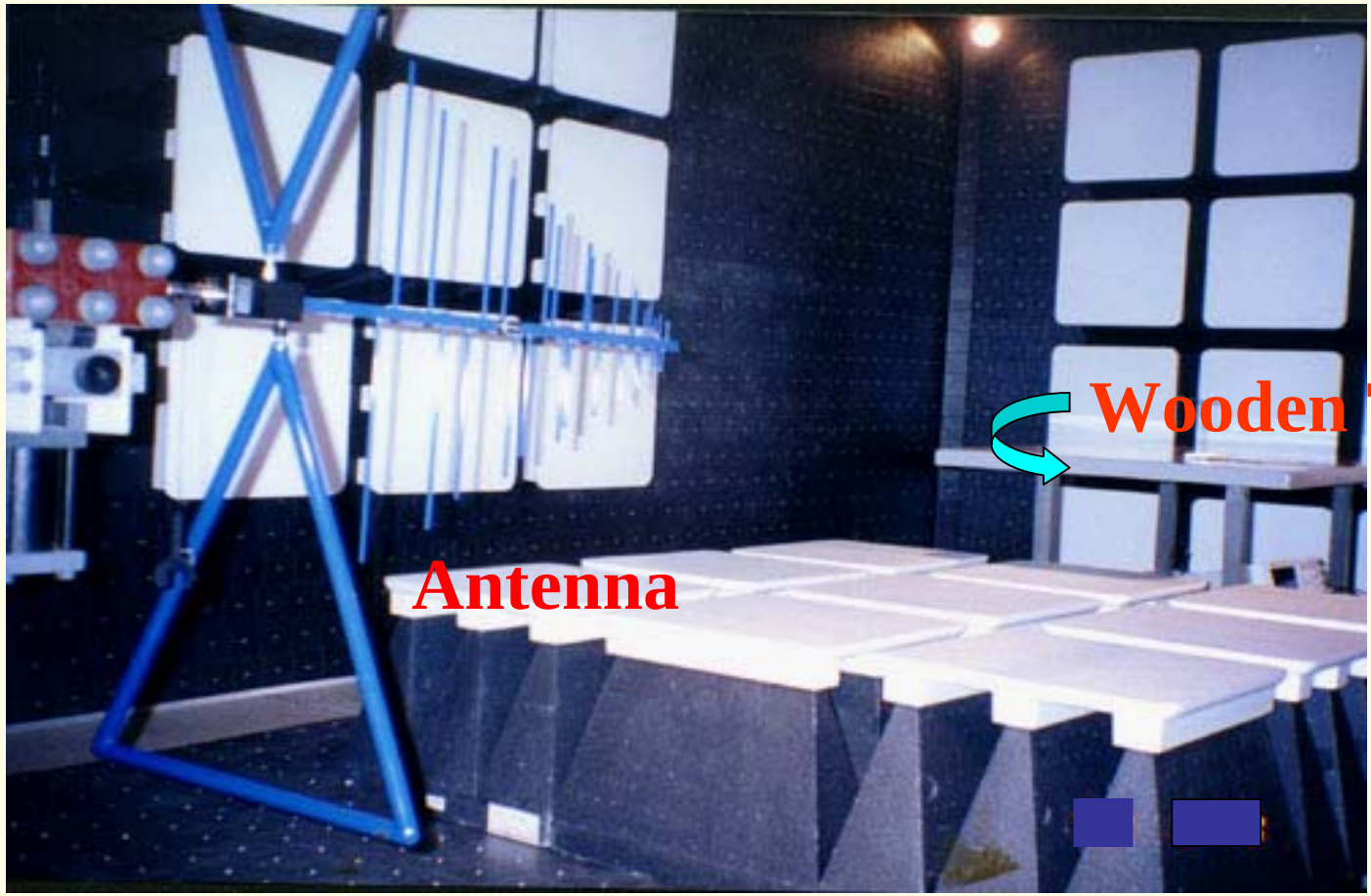


(d) HCNC

Comparison of SE Performance of Nylon, LCP, WCCF and HCNCs Composites

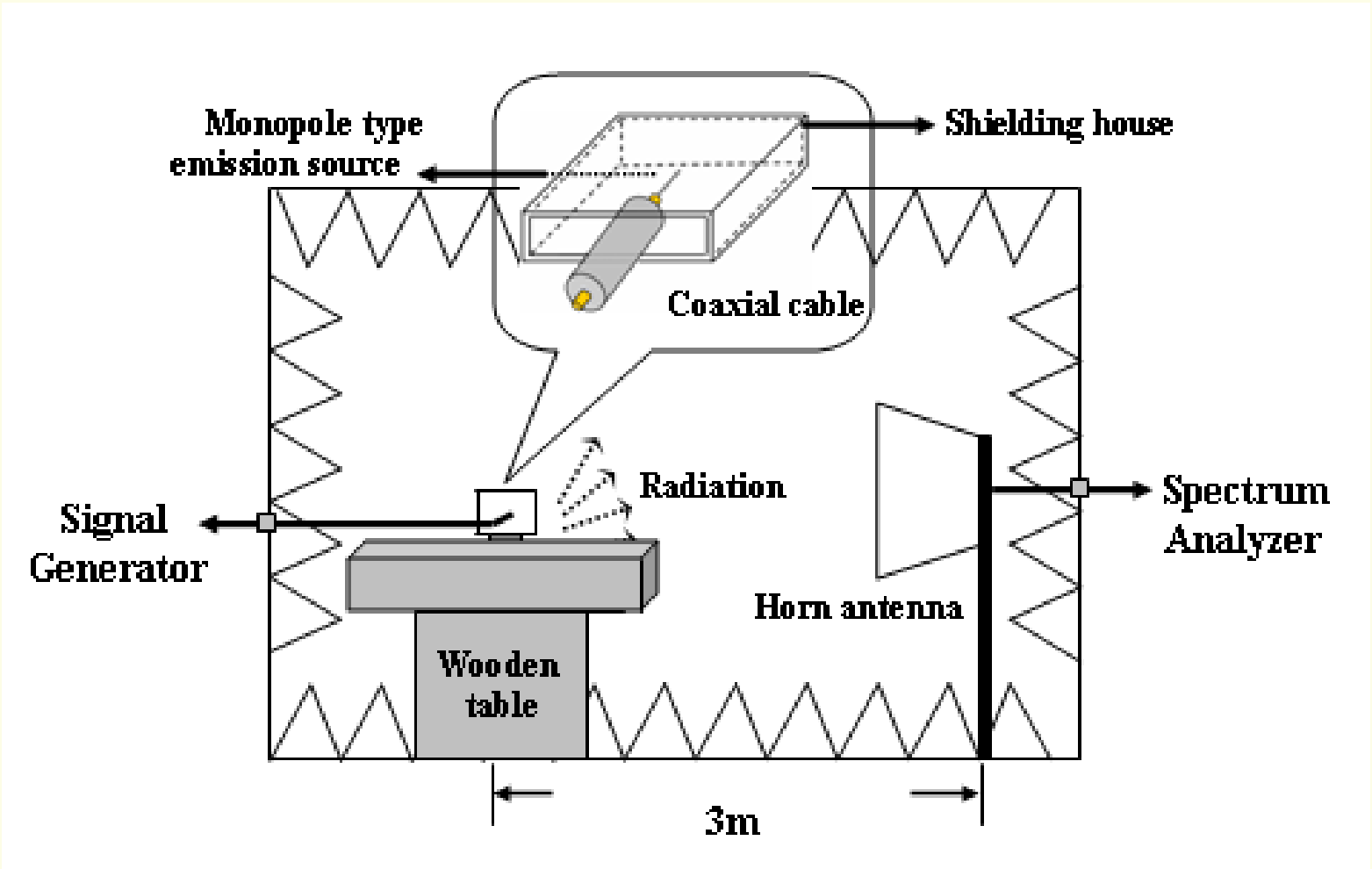


Anechoic Chamber

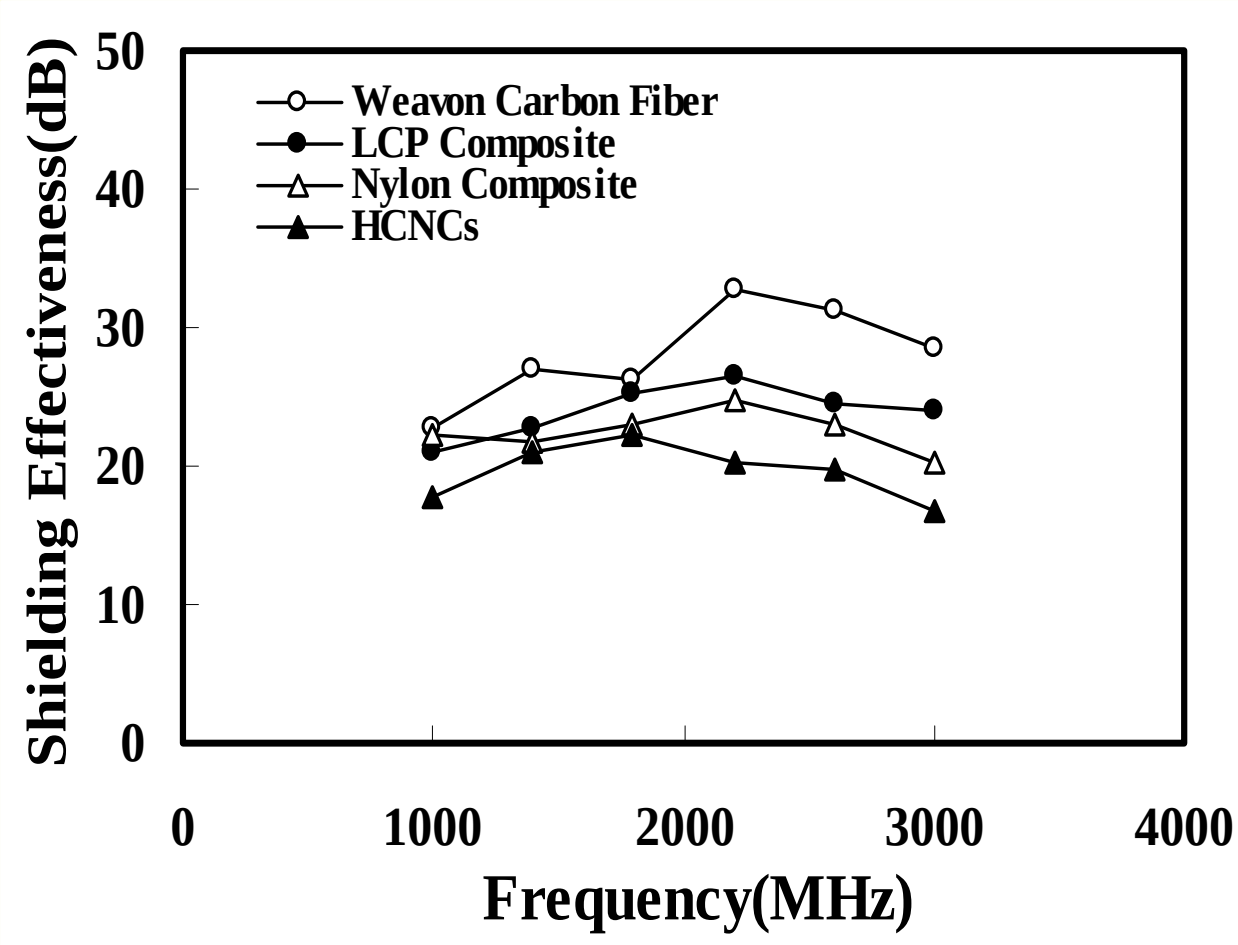


Chamber volume = 7m x 4m x 3m

S.E. measurement for near-field monopole-type source in a fully anechoic EMC chamber



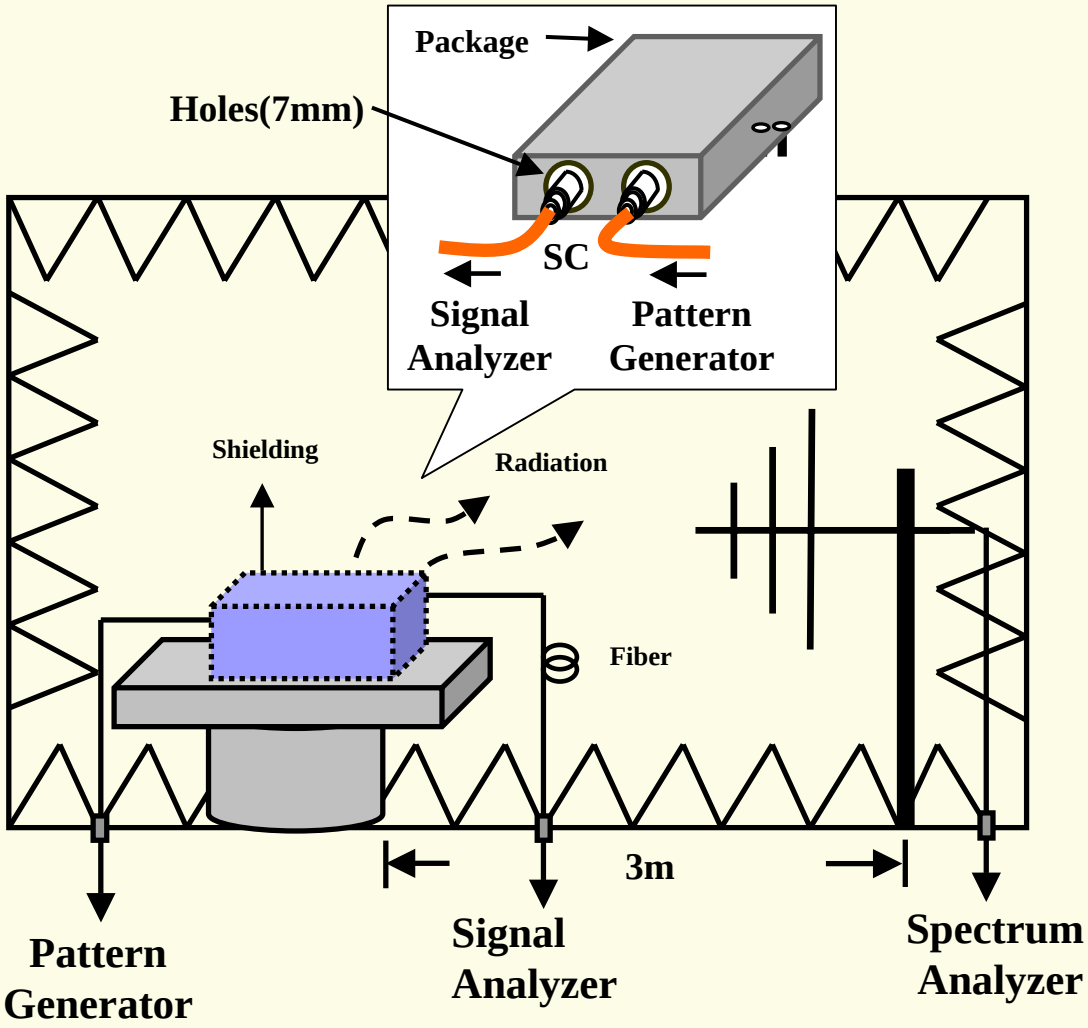
Comparison of SE performance of realistic housings fabricated by HCNCs composites



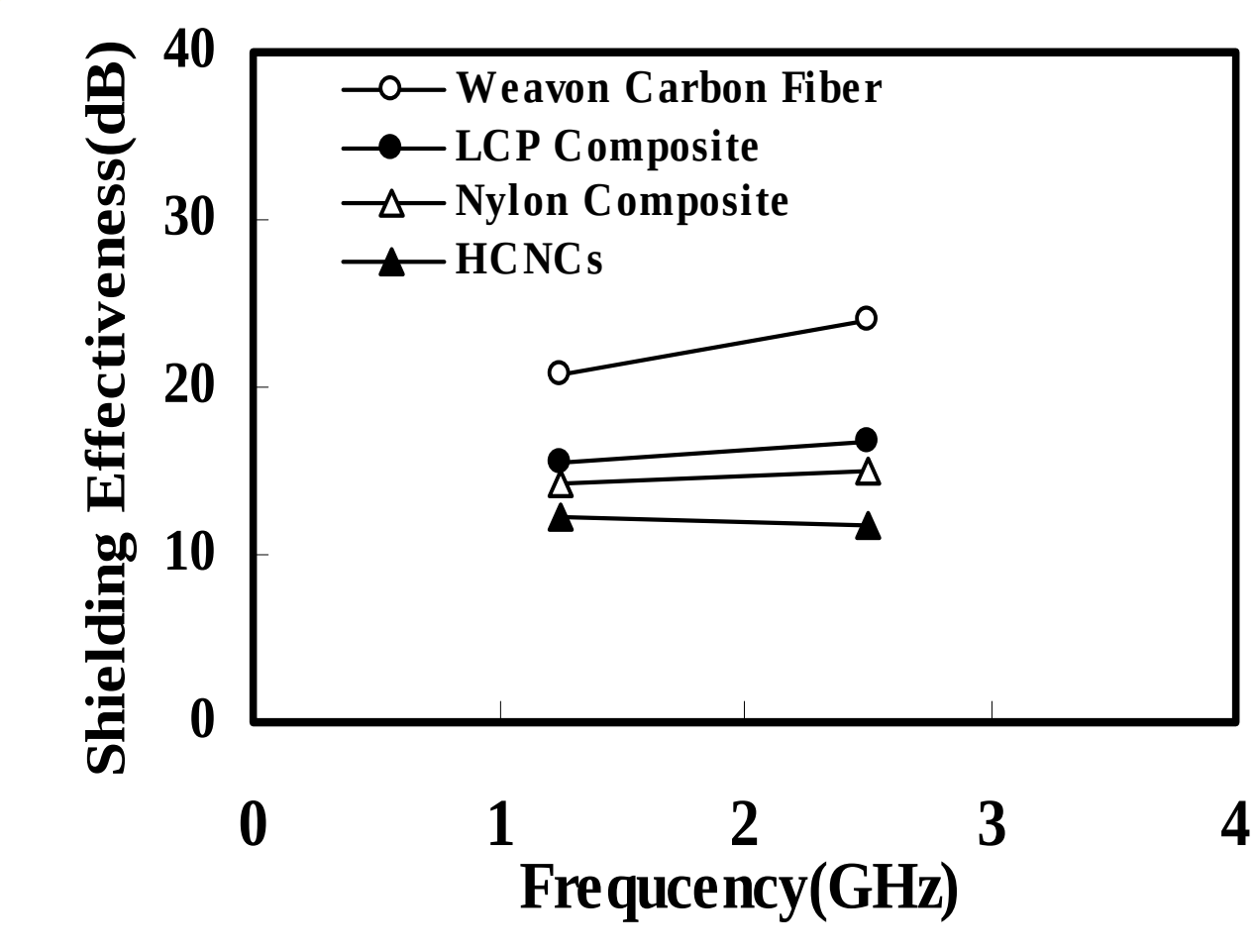
Comparison of cost, and shielding performance of plastic composites

Sample	Material (Cost/g)	Filler (Cost/g)	Weight of Filler (g)	Total Weight (g)	Thickness of Sample (mm)	Cost of Sample (US)	SE (dB)
Nylon Composite	Nylon-66 (8.8×10^{-3})	Carbon Fiber (2.3×10^{-2})	16.6	83	3	0.96	40~50
LCP Composite	LCP (2.3×10^{-2})	Carbon Fiber (2.3×10^{-2})	16.6	83	3	1.91	40~50
Weavon Carbon Fiber	Epoxy (8.8×10^{-3})	Carbon Fiber (2.3×10^{-2})	2	4	0.5	0.06	40~50
Carbon Nanocaplsule	Epoxy (8.8×10^{-3})	Carbon Nanocaplsule (5.88)	7	9	0.5	41	40~50

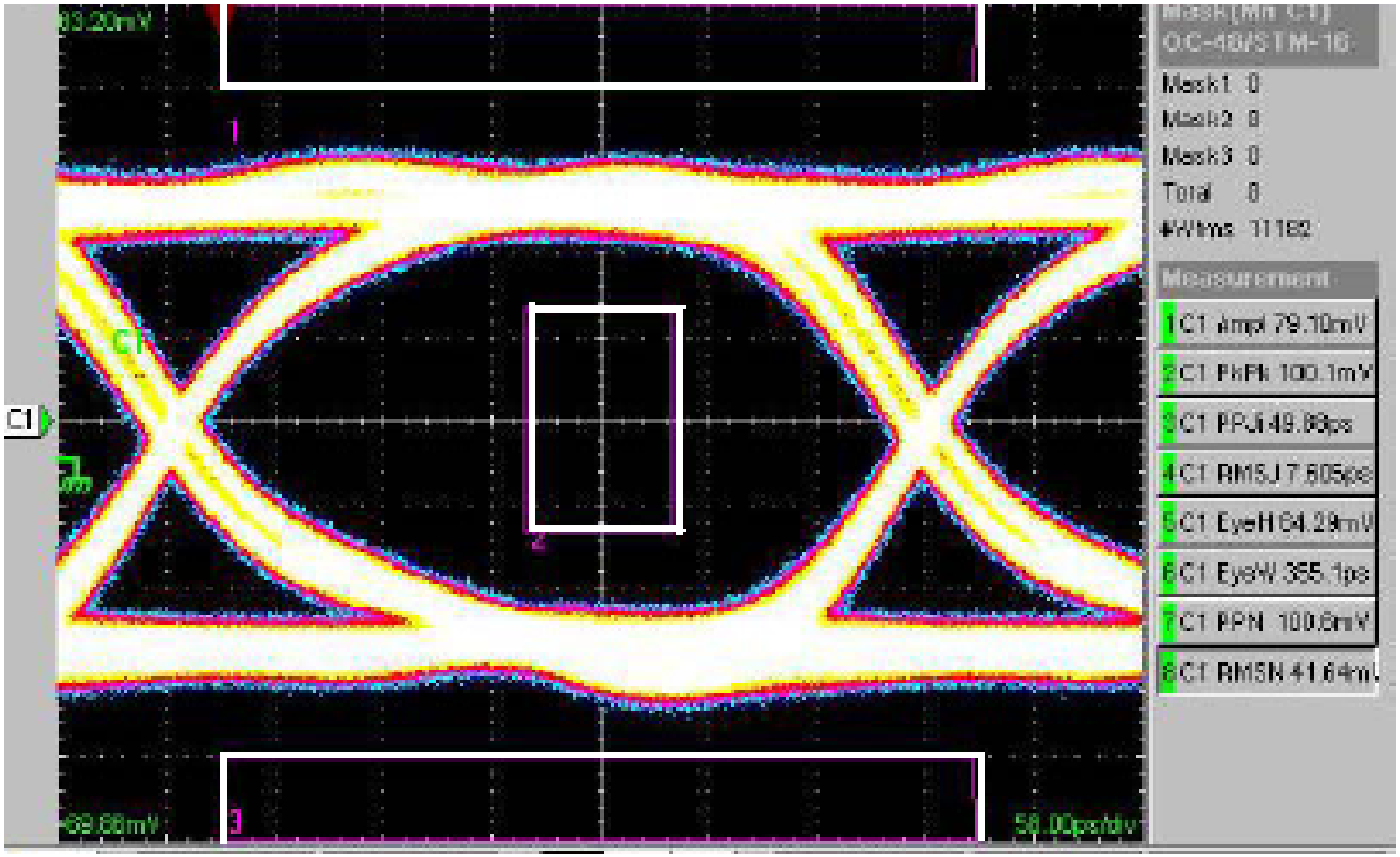
Measurement setup of the radiated emission for the optical transceiver module in normal operation



Comparison of SE performance of optical transceiver modules at 1.25 GHz and 2.5 GHz fabricated by nylon, LCP, WCCF and HCNCs composites



Eye Diagram of 2.5Gb/s Transmitter



Comparison of cost, and shielding performance of optical transceiver modules

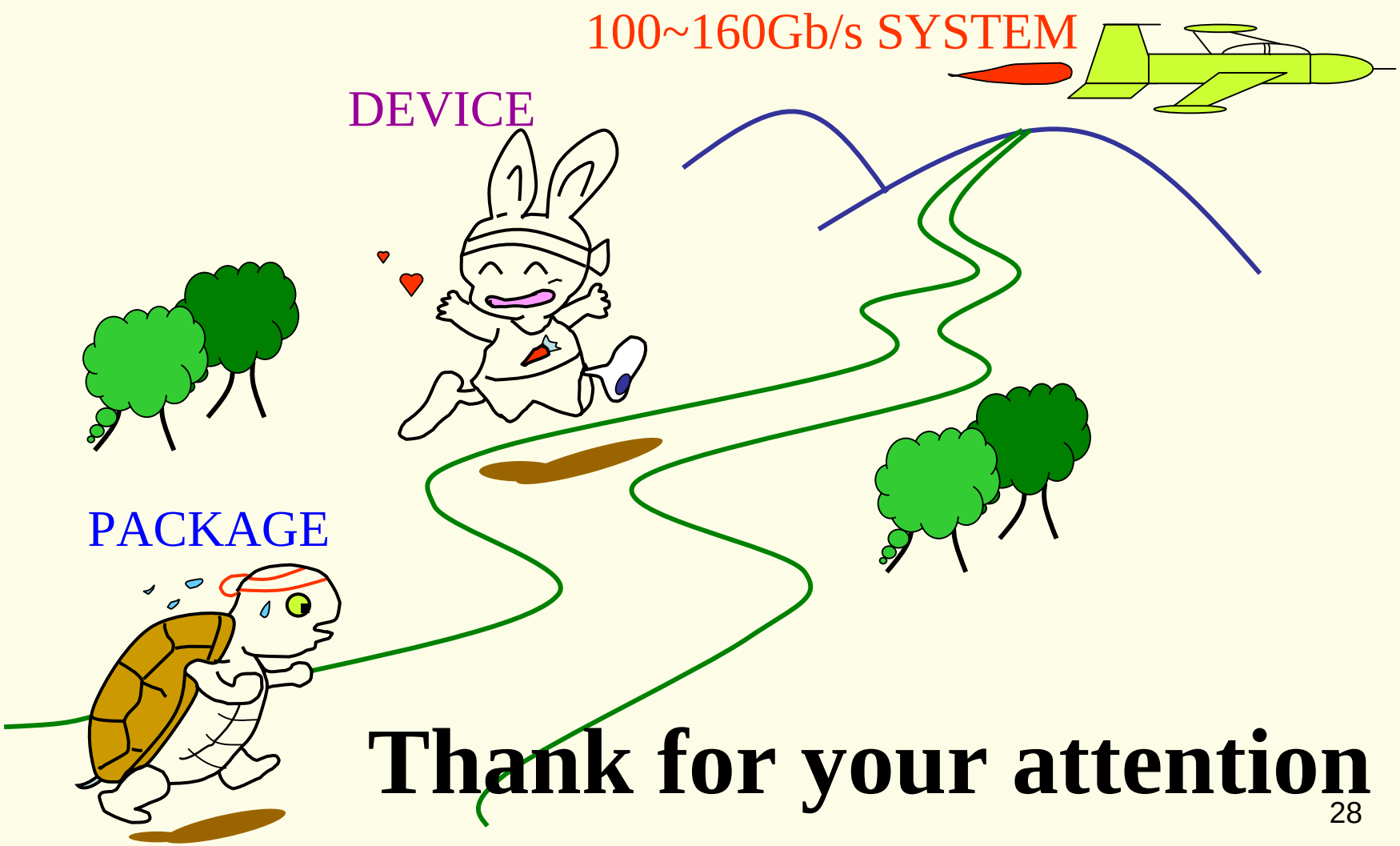
Sample	Material (Cost/g)	Filler (Cost/g)	Weight of Filler (g)	Total Weight (g)	Thickness of Sample (mm)	Cost of Sample (US)	SE (dB)
Nylon Composite	Nylon-66 (8.8×10^{-3})	Carbon Fiber (2.3×10^{-2})	12.8	51.5	3	0.64	15
LCP Composite	LCP (2.3×10^{-2})	Carbon Fiber (2.3×10^{-2})	12.8	51.5	3	1.18	17
Weavon Carbon Fiber	Epoxy (8.8×10^{-3})	Carbon Fiber (2.3×10^{-2})	1.24	2.5	0.5	0.04	24
Carbon Nanocaplsule	Epoxy (8.8×10^{-3})	Carbon Nanocaplsule (5.88)	6	8	0.5	35	12

Conclusion

Low-cost optical transceiver modules with transmission rates of 155Mb/s, 1.25Gb/s, and 2.5Gb/s were successfully fabricated to investigate the EM shielding ability.

- **The LCP composites perform better SE than the nylon66. This is the LCP polymer chains have higher ordering structure under both melting and solid state.**
- **By comparison of cost, weight and shielding performance for optical transceiver modules fabricated by the housings of nylon, LCP, WCCF and HCNCs composites, the WCCF composite showed lower cost, lighter weight and higher EM shielding than the other types of composites.**
- **Due to the fact that the electronic and mechanical properties of HCNCs composites are remarkable, future research and development may push to develop the low cost and low EMI optical transceiver modules using nanoscale HCNCs.**
- **The packaged plastic optical transceiver modules with low cost and low EMI are suitable for use in Gigabit Ethernet or fiber to the home lightwave (FTTH) communication systems.**

Turtle Spirit：Making a low-cost package affort step by step



Thank for your attention