

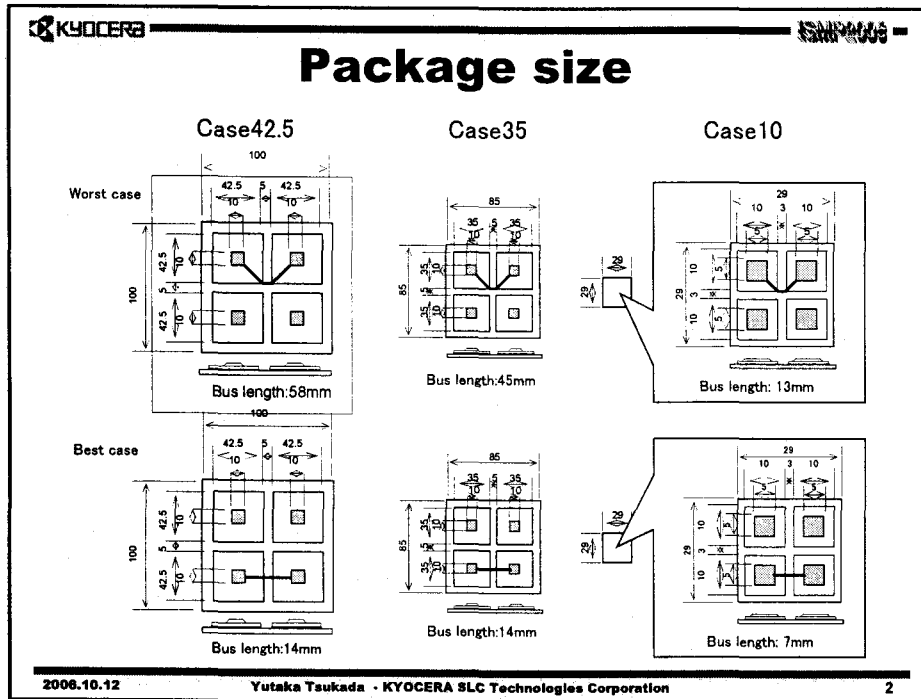
**A Consideration of High Speed Signal
Transmission in Chip Carrier and Future
Direction**

Yutaka Tsukada
(Kyocera SLC Technologies /Japan)

High Speed Signal Transmission in Flip Chip Carrier and Future Direction

Yutaka Tsukada

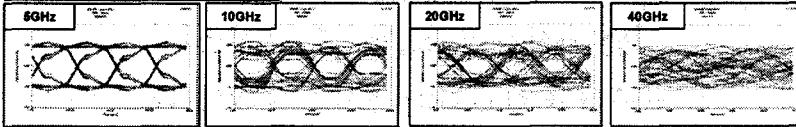
Advanced Packaging Laboratory
KYOCERA SLC Technologies Corporation



Worst case



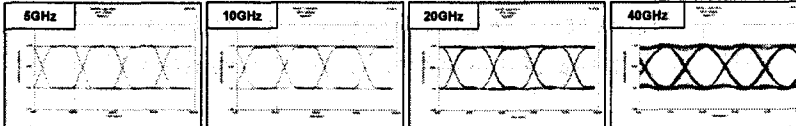
BGA carrier size: 42.5x42.5mm Line/space: 25 μ m/25 μ m, BGA Pitch: 1,000 μ m, Total length: 14,360 μ m



BGA carrier size: 35x35mm Line/space: 20 μ m/20 μ m, BGA Pitch: 800 μ m, Total length: 13,652 μ m



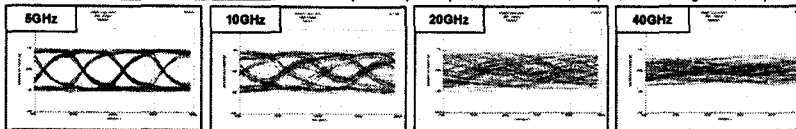
BGA carrier size: 10x10mm Line/space: 8 μ m/8 μ m, BGA Pitch: 200 μ m, Total length: 6,850 μ m



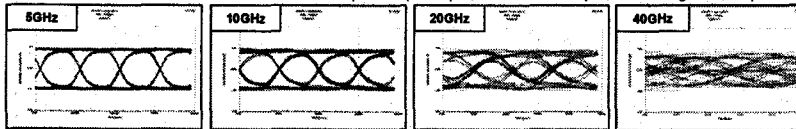
Best case



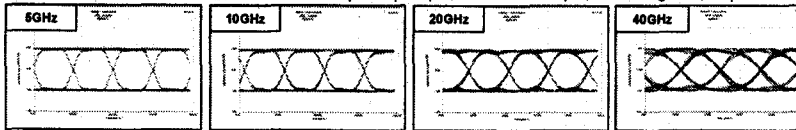
BGA carrier size: 42.5x42.5mm Line/space: 25 μ m/25 μ m, BGA Pitch: 1,000 μ m, Total length: 58,168 μ m



BGA carrier size: 35x35mm Line/space: 20 μ m/20 μ m, BGA Pitch: 800 μ m, Total length: 45,460 μ m



BGA carrier size: 10x10mm Line/space: 8 μ m/8 μ m, BGA Pitch: 200 μ m, Total length: 12,790 μ m



Return loss by via hole

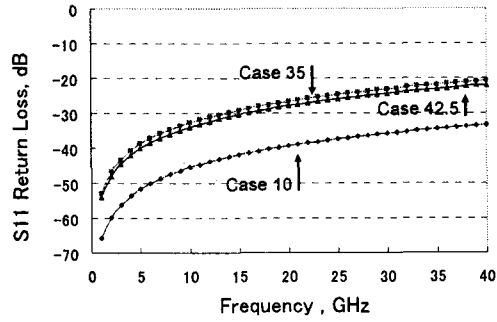
Case 42.5



Case 35



Case 10



Model parameter	via diameter	via height	land diameter	Cu thickness
Case 42.5	52μm	35μm	95μm	13μm
Case 35	52μm	30μm	80μm	18μm
Case 10	15μm	10μm	25μm	5μm

Insertion loss by via hole

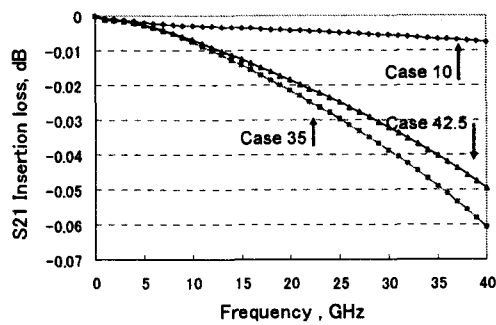
Case 42.5



Case 35

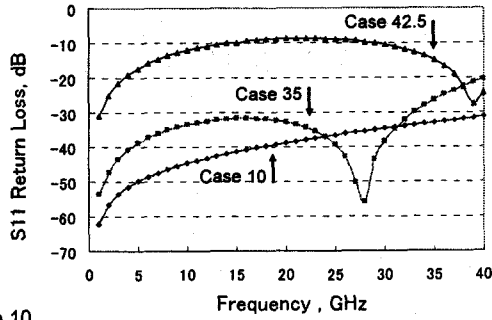
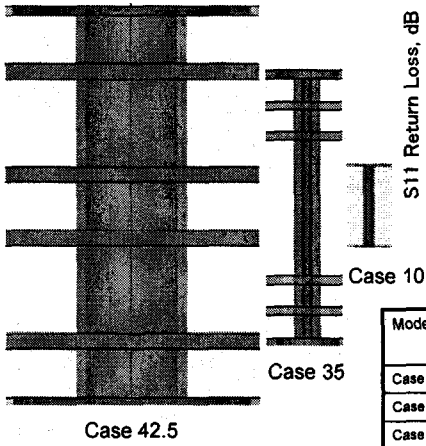


Case 10



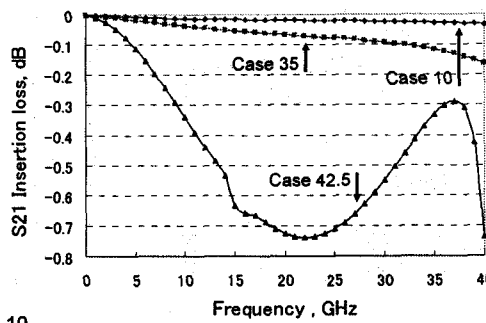
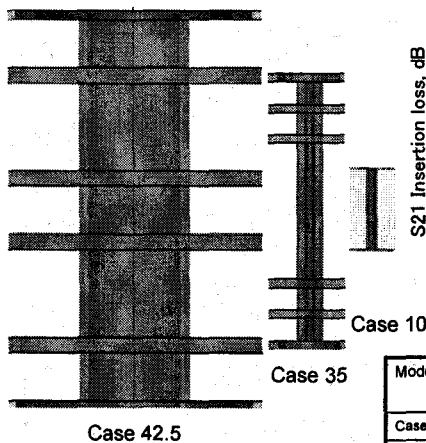
Model parameter	via diameter	via height	land diameter	Cu thickness
Case 42.5	52μm	35μm	95μm	13μm
Case 35	52μm	30μm	80μm	18μm
Case 10	15μm	10μm	25μm	5μm

Return loss by through hole



Model parameter	via diameter	via height	land diameter	Cu thickness
Case 42.5	250 μ m	870 μ m	450 μ m	13 μ m
Case 35	60 μ m	572 μ m	140 μ m	18 μ m
Case 10	30 μ m	200 μ m	40 μ m	5 μ m

Insertion loss by through hole



Model parameter	via diameter	via height	land diameter	Cu thickness
Case 42.5	250 μ m	870 μ m	450 μ m	13 μ m
Case 35	60 μ m	572 μ m	140 μ m	18 μ m
Case 10	30 μ m	200 μ m	40 μ m	5 μ m

Return loss by BGA

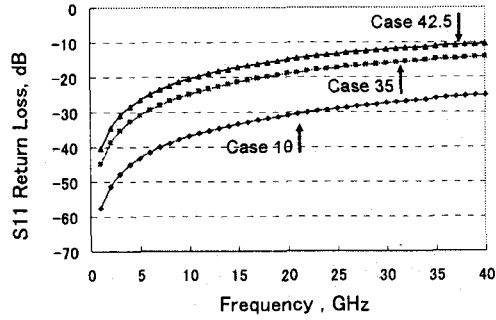
Case 42.5



Case 35



Case 10



Model parameter	BGA diameter	BGA height	pad diameter	Cu thickness
Case 42.5	650 μ m	400 μ m	520 μ m	13 μ m
Case 35	500 μ m	350 μ m	380 μ m	18 μ m
Case 10	140 μ m	100 μ m	100 μ m	5 μ m

Insertion loss by BGA

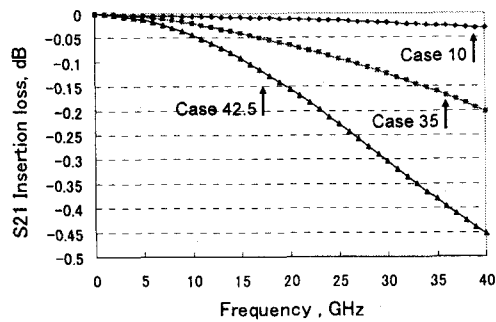
Case 42.5



Case 35



Case 10



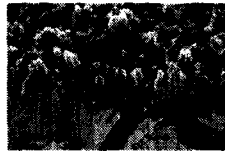
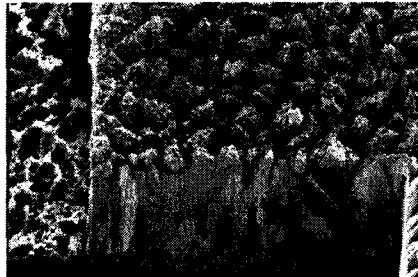
Model parameter	BGA diameter	BGA height	pad diameter	Cu thickness
Case 42.5	650 μ m	400 μ m	520 μ m	13 μ m
Case 35	500 μ m	350 μ m	380 μ m	18 μ m
Case 10	140 μ m	100 μ m	100 μ m	5 μ m

Conductor surface roughness

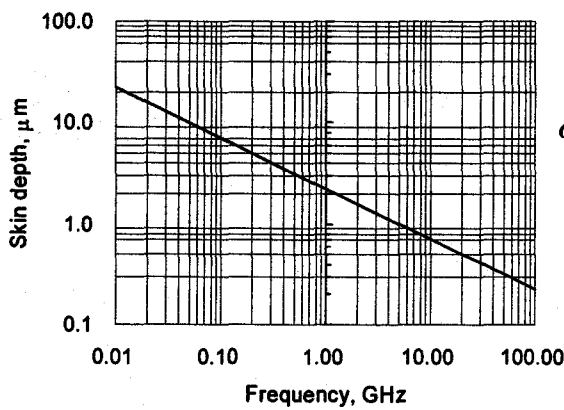
Oxidation



Grain boundary etching



Skin depth



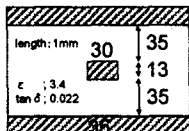
$$\delta = \frac{1}{\sqrt{\omega\mu\sigma}} [m]$$

$\omega : 2\pi f$
 $\mu : 4\pi \times 10^{-7} [H/m]$
 $\sigma : 50 \times 10^6 [H/m]$

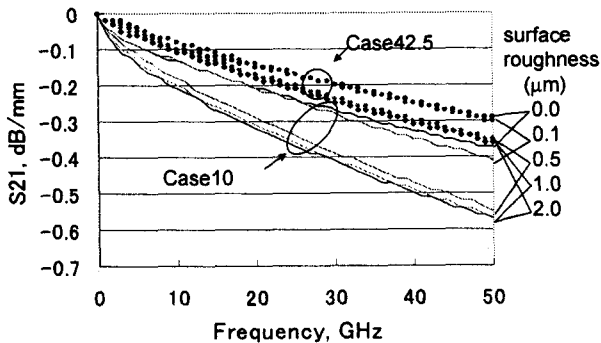
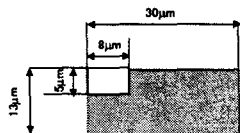
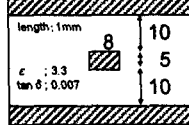
f (GHz)	0.1	1.0	10	20	30	40	50
δ (μm)	7.12	2.25	0.71	0.50	0.41	0.36	0.32

Influence by design rule

Case42.5



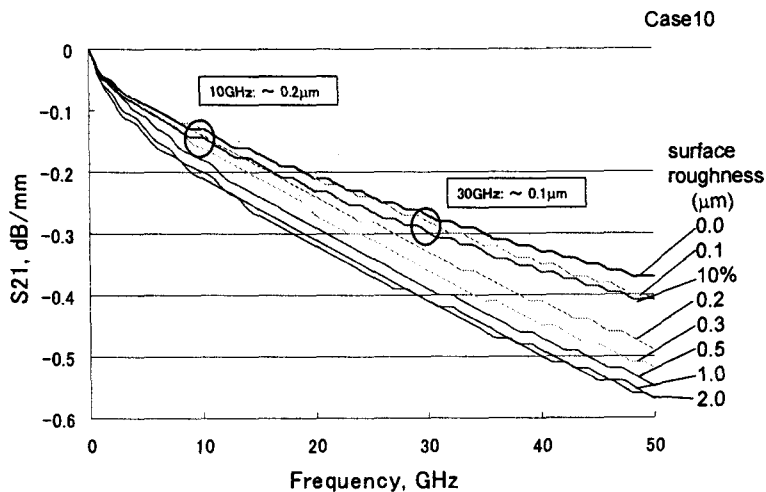
Case10

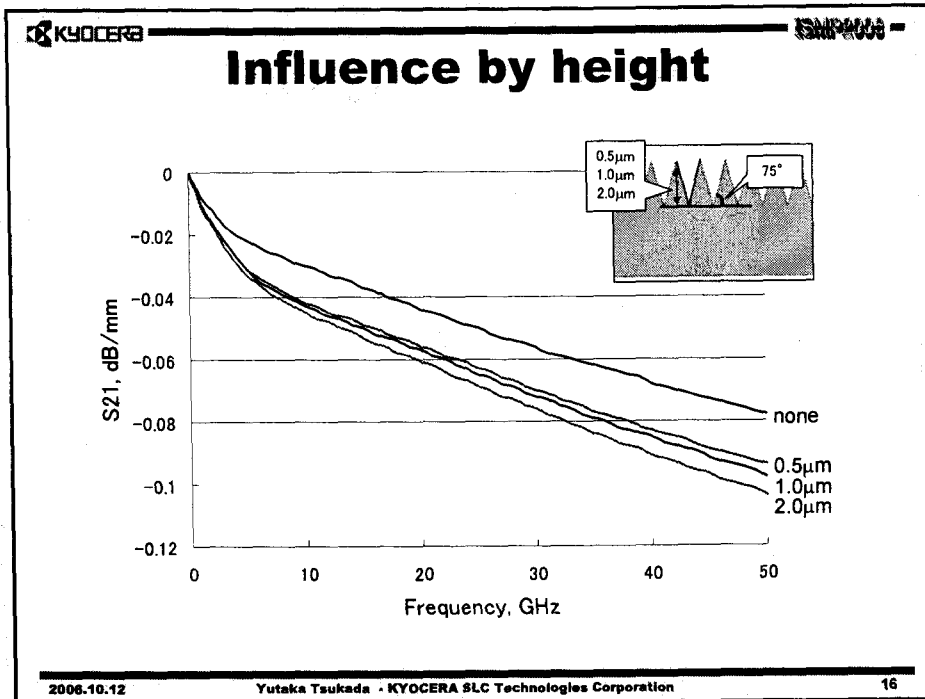
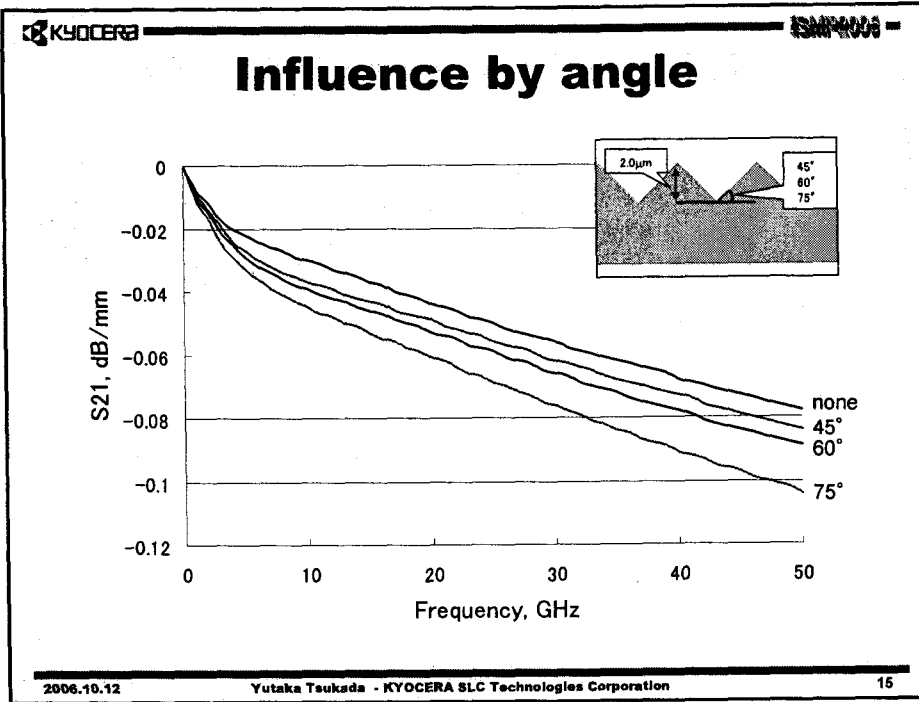


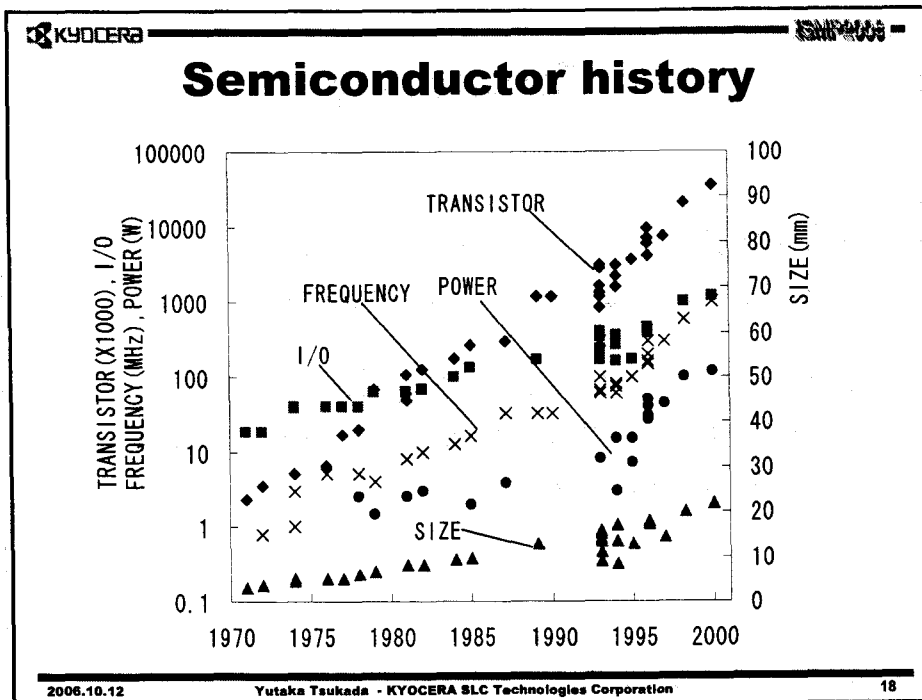
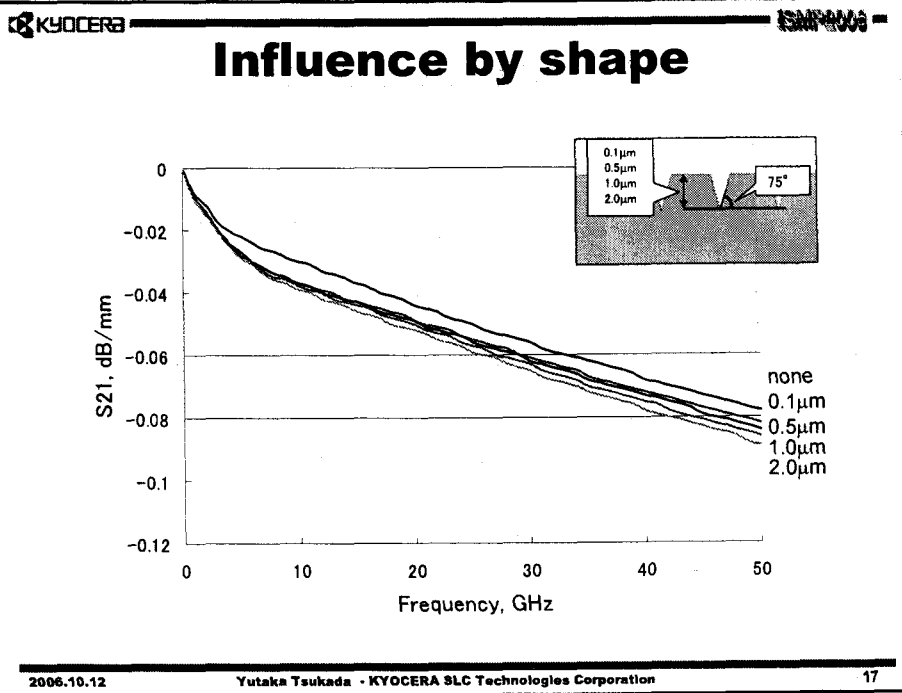
$$\sigma_c = \frac{\sigma}{K_w^2} \quad K_w = 1 + \exp\left(-\frac{s}{2h}\right)^{1.6}$$

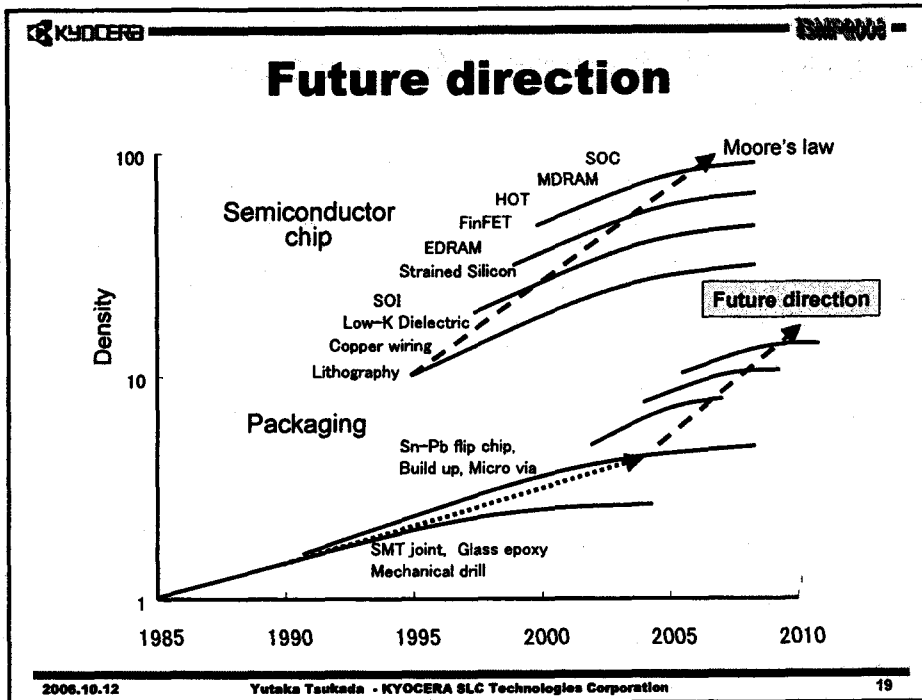
σ : conductivity h : Ra, s : skin depth

Allowable roughness









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Summary

- Miniaturization of packaging size is a key for system performance.
- Fundamental density increase of joint and carrier wiring are required in near future.

2006.10.12 Yutaka Tsukada - KYOCERA SLC Technologies Corporation 20