

Haeseong Lee

Jeonju University



2024-09-23

The 18th US/Korea Nanoforum

The Birth of Semiconductor Industry

Bipolar



MOS



Channel Length = Gate Length - 2 x (Diffusion Length)





2

The Roadmap of CMOS



Process	Gate pitch	Metal pitch	Year
7 nm	60 nm	40 nm	2018
5 nm	51 nm	30 nm	2020
3 nm	48 nm	24 nm	2022
2 nm	45 nm	20 nm	2024
1 nm	42 nm	16 nm	2026

https://www.tel.com/museum/magazine/material/150227_report04_01/

Technical hindrance?

- > Overtly "Tunneling phenomenon"
- > Covertly "Electromagnetic Inteference"

A Technical Tree related to EMI



Electromagnetic Interference (EMI)

Degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance.

Electromagnetic Susceptibility (EMS)

The tolerance of circuits and components to all sources of interfering electromagnetic energy.

Electromagnetic Compatibility (EMC)

The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

Why E_x/E_y and E_z are separated?



Motivation from Electric automobile

Is it a machinery product or an electric product?



Motivation from Wearable Electronics



Motivation form Printed Electronics













Products

시험방법	사용 주파수 대역		전기장	MUT	데이터	동작 영역	측정	측정시간
	하한	상한	형태	요구사항	이론적 해석	(dB)	반복도	(hrs)
Modified MIL-std- 285	30 MHz	1 GHz	Unknown	Cover an aperture	Poor	80-90	Poor	30-40
ASTM ES 7-83	1 MHz	1 GHz	Normal Plane wave	Annular disk	Good	90-100	Moderate	0.25
ASTM D4935	1 MHz	1 GHz	Normal Plane wave	Circular + Reference ring & disk	Good	90-100	Good	0.25
Time Domain	200 MHz	3.5 GHz	Normal Plane wave	Large sheet Cover an aperture	Good Moderate	56-60 40-50	Good Good	0.25 0.25
Dual TEM Cell	1 MHz	1 GHz	Near-field or Grazing plane wave	Cover an aperture	Good	50-60	Good	0.5
Apertured TEM Cell	200 MHz	1 GHz	Near-field	Cover an aperture	Good	90-100	Good	3-4

ASTM D4935





> A sample with more than 14 cm diameter should be prepared !!

- Only available under far-field condition
- > 30MHz to 1.5 GHZ

Examples of EMI standards on materials used in industry

Sta	ndards Tested To	Products Tested				
IEE	E 299	Gaskets				
MIL	DTL-83528	Composite Materials				
MII	G-83528	Conductive Coatings/Paints				
MII	STD-285	Electro-Plated Plastics				
MII	STD-907B	Conductive Plastics				
MII	STD-1377	Conductive Treated Plastics				
AS	ГМ-D-4935	Conductive Treated Materials				
ECA EIA-364-66A TP 66A		Foils				
NS/	A 65-6	Enclosures				
SCTE 48-1-2006		Surface Mount Shields				
		Cables Laminates				
						Lack of EMC standards on
Fabrics						
Shielded Windows/Lenses						
nanomaterials !	Artificial Products					

Case of nanomaterials

- Characteristics in nanomaterials : Low-dimensionality
- Sample amount : extremely small
- Measurement methods : Near-field vs Far-field or any other method(s)?
 - Sample prep is very important!





For DWCNT ? For graphene?

For composites?

For MWCNT

For SWCNT

The current status of measurement





Creating a new technical group under standardization society

> IEC TC113 WG 14 from 2018

Our trial method

Improvement in a sample holder





Sample preparation – SWCNT with/without metal contents



Our results on SWCNT



IEC TS 62607-11-2 under IEC TC113 WG14

Near-field measurement system



IEC TS 62607-11-1 under IEC TC113 WG14

Nanomaterials for EMC



Resistivity (ohm cm)

EM used at various electronic devices



from E-Song EMC Products Guide

New Growth Engines for the Semiconductor Tech.









We need EMC on Nanomaterials in all cases !

Thank you very much !

Jeonju University Korea Testing Laboratory Korea Institute of Convergence on Textile Prof. Haeseong Lee Mr. Hyeongrok Yu Mr. Sang-Wook Yoon Mr. Hahnhee Lee Dr. Jung Soo Kim

Contact to haeseong919@gmail.com or haeseong@jj.ac.kr