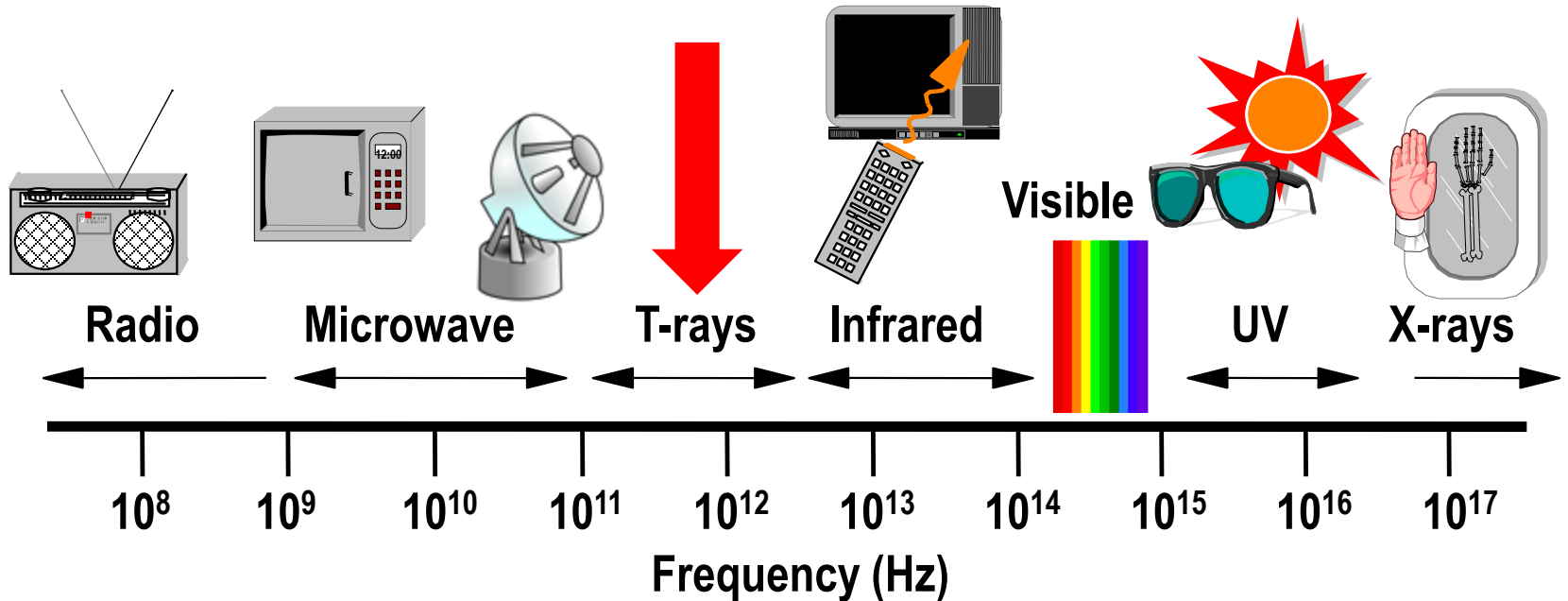




Terahertz 기술 소개자료



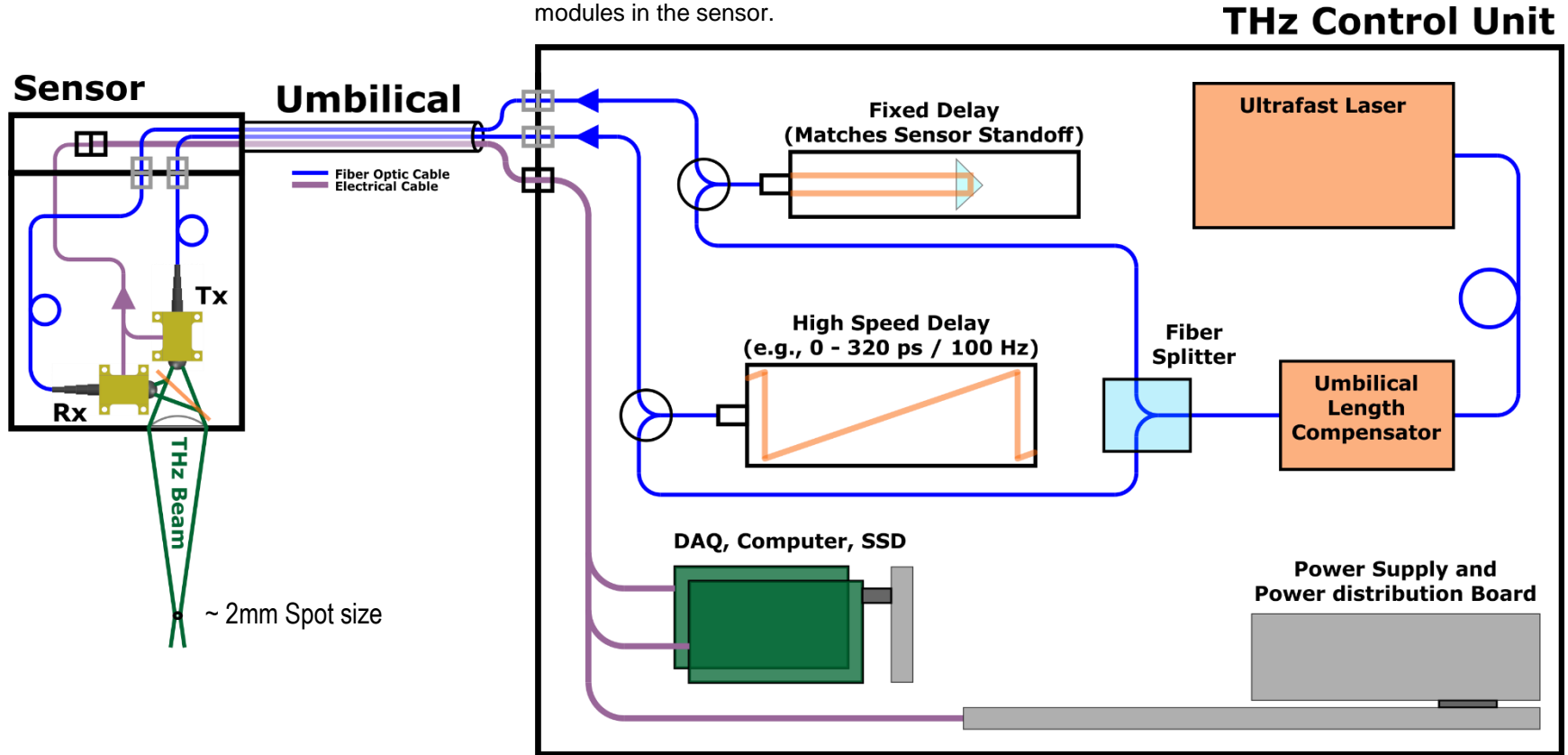
THz operates between Far IR & Microwave



$$\nu = 1 \text{ THz} \quad \longleftrightarrow \quad \lambda = 300 \text{ } \mu\text{m} \quad \longleftrightarrow \quad h\nu = 33 \text{ cm}^{-1} \quad \longleftrightarrow \quad 4.1 \text{ meV} \quad \longleftrightarrow \quad T = 48 \text{ K}$$

TD-THz System의 구성

Note: Ultrafast laser pulses are **SENT** to both the Tx and Rx modules in the sensor.



구성



센서 헤드

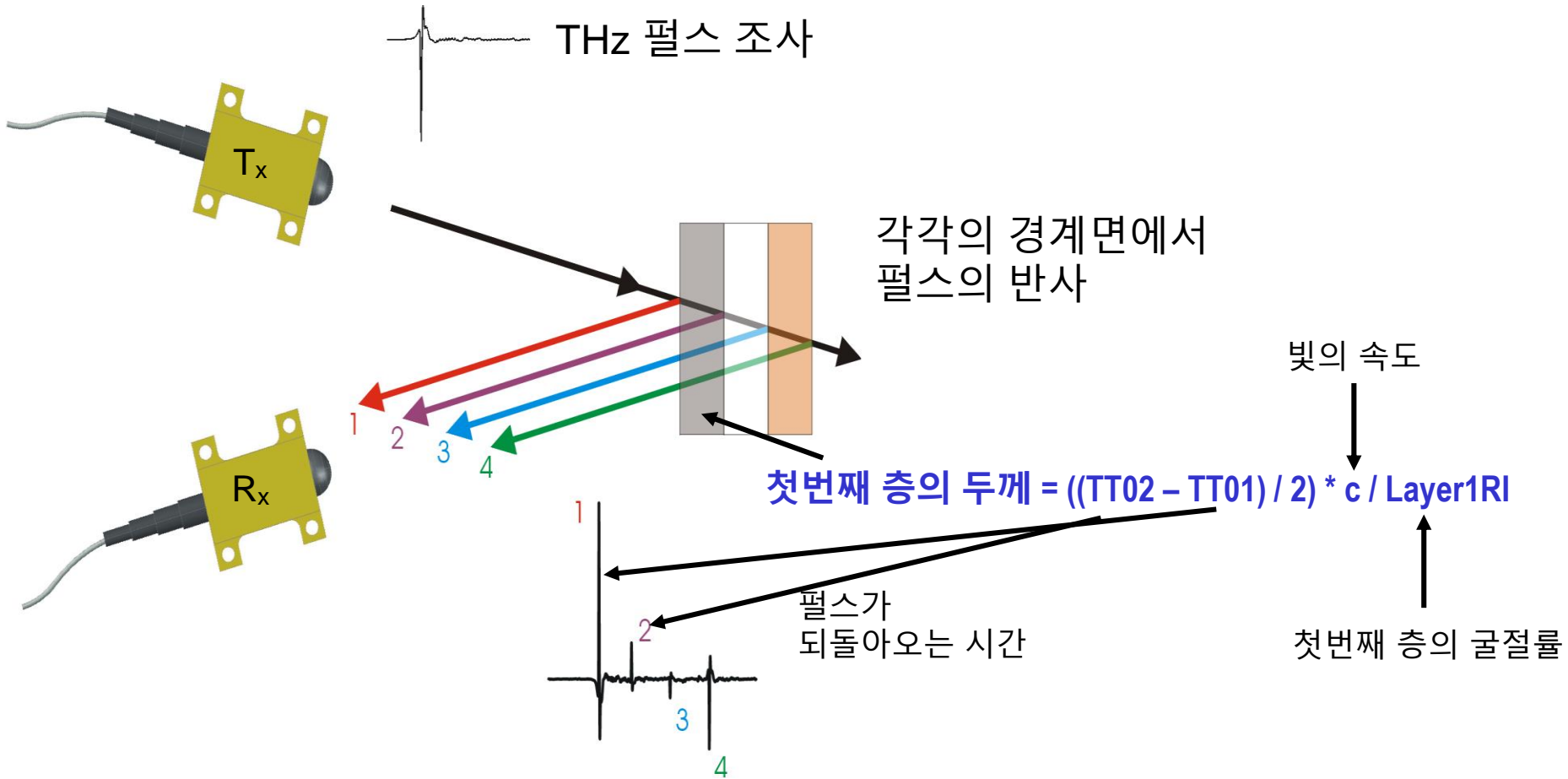


컨트롤러

스펙

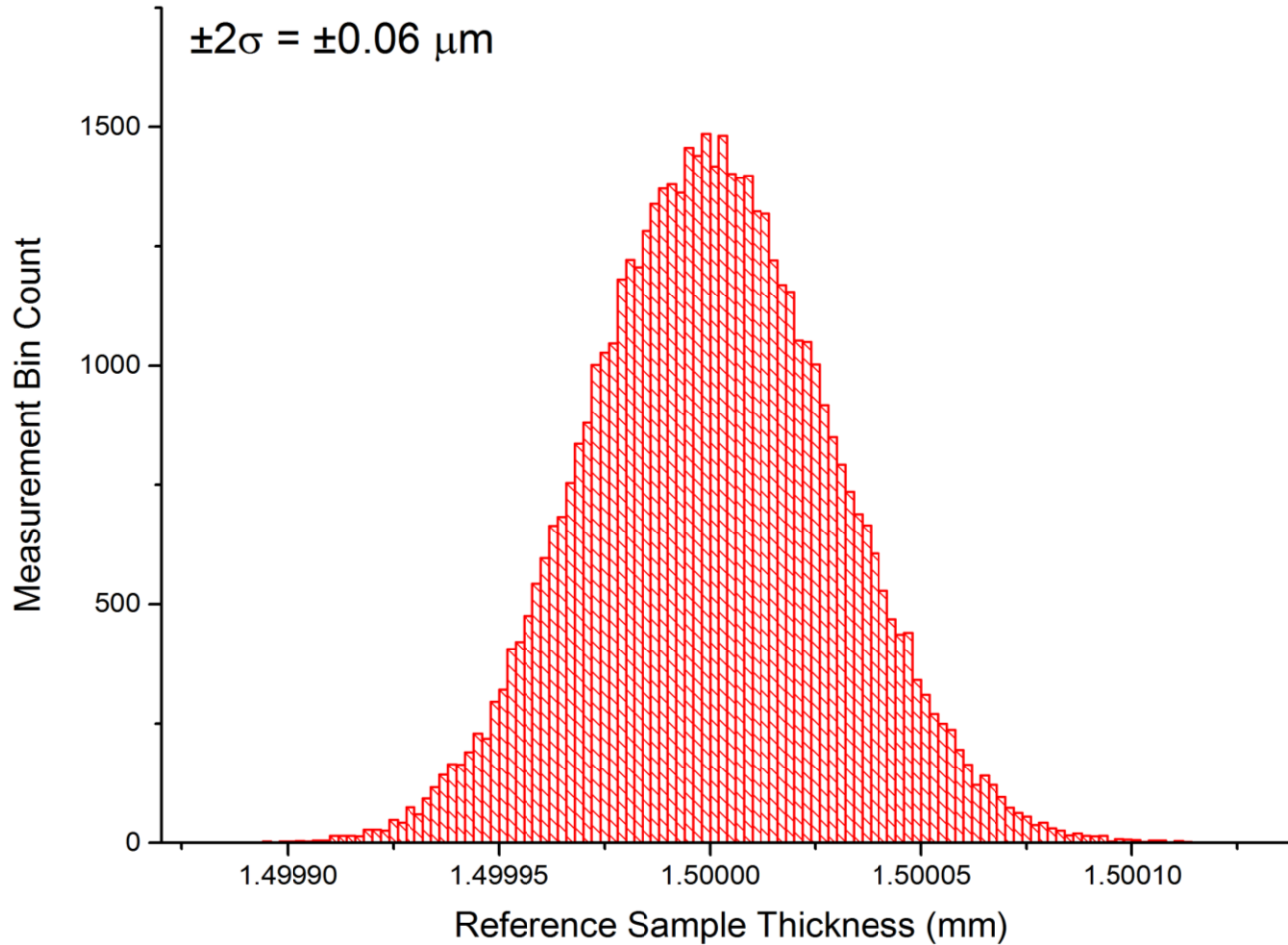
Parameter	Specification
측정 타입	Time Domain THz
측정 시간	평균 0.25초, 최소 0.001초
측정 속도	100Hz - 320ps and 700ps 1000Hz - 80ps and 160ps
두께 측정 범위	0.005 ~ 8 mm (80ps) 0.005 ~ 17mm (160ps) 0.005 ~ 40mm (320ps) 0.005 ~ 100mm (700ps)
두께 측정 정밀도	$\pm 0.1\mu\text{m}$ ~ $\pm 0.5\mu\text{m}$
이격 거리	25mm, 75mm, 150mm
스팟 사이즈	2mm(focal length)
작동 온도	0 ~ 50°C

Sensor Reflection(s)

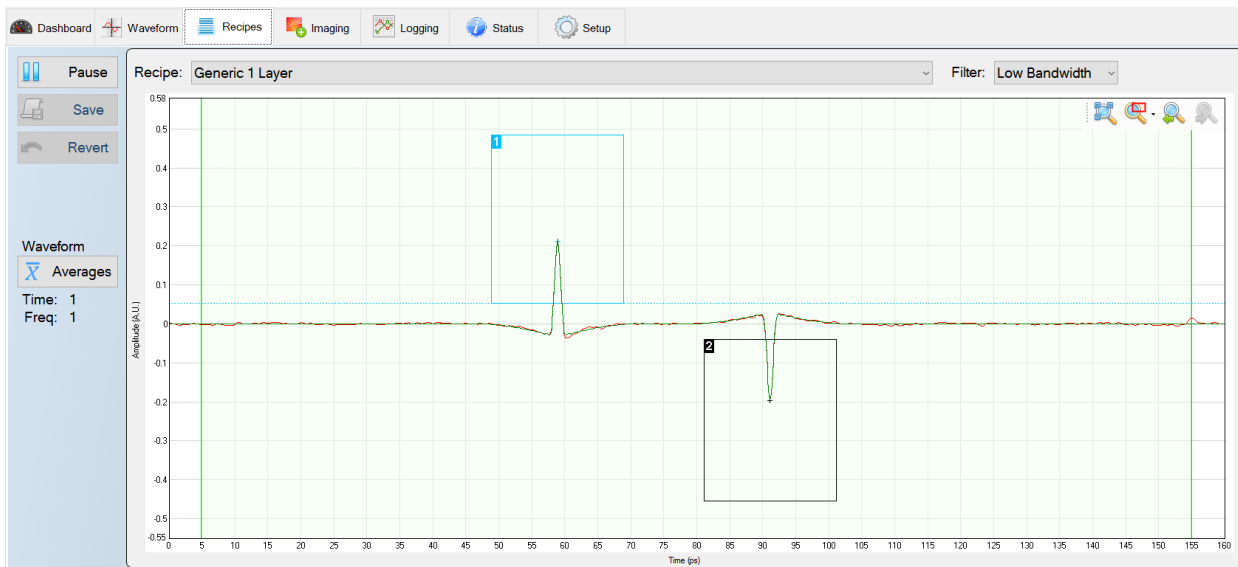


THz와 다른 두께 측정 방식 비교

	Safe for humans	Penetrates Opaque	Non-contact	Multiple layer measurements	Measures thickness
TD-THz	X	X	X	X	X
Nuclear		X	X		
X-Ray		X	X		
Thermal(Optisense)	X	X	X		X
Infrared	X		X	X*	
Optical coherence	X		X	X	X
Laser	X		X		X
Eddy current	X	X			X
mm-Wave	X	X	X		
Ultrasound	X	X		X	X



- quartz window의 50,000회 측정 결과



편리한 소프트웨어

1. 피크영역 설정
2. 계산 프로그래밍
3. 두께, 밀도, 갭여부 등의 출력 설정

Peaks Layers Script TD/FD Calc Advanced

Input Variables Calculations Formula Word Wrap Output Variables

TT01	58.91	1	Layer1RI = 1.5166	<input type="button" value="^"/> <table border="1"> <tbody> <tr> <td>OP00</td> <td>58.91</td> </tr> <tr> <td>TH00</td> <td>3.18</td> </tr> </tbody> </table> <input type="button" value="v"/>	OP00	58.91	TH00	3.18
OP00	58.91							
TH00	3.18							
TT02	91.12	2						
AA01	0.22	3						
AA02	-0.19	4	milspss = 11.803					
VV01	1	5	mmpps = 0.29979					
VV02	1	6	Lightspeed = mmpps					
		7						
		8	TH00 = ((TT02 - TT01) / 2) * Lightspeed / Layer1RI					
		9	OP00 = TT01					
		10						
		11						



코팅된 스테인리스 파이프

Peak1 = 코팅 표면

Peak2 = 금속 파이프 표면

Peak1의 시간 = 143.8ps

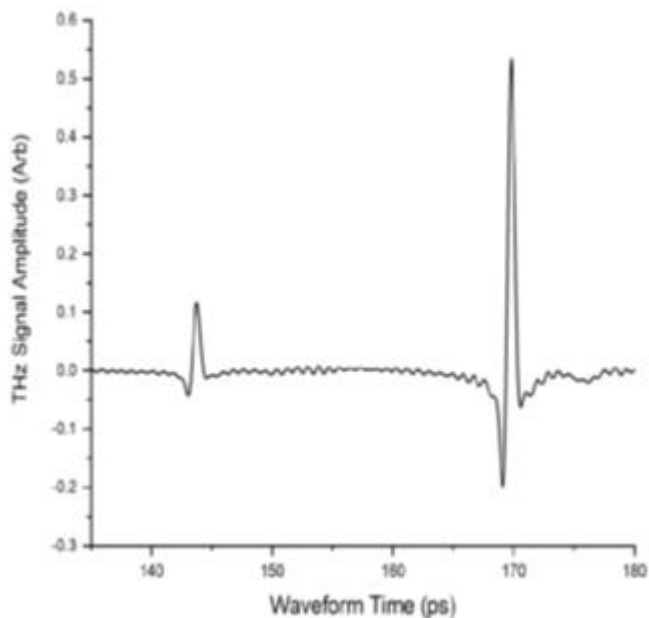
Peak2의 시간 = 169.8ps

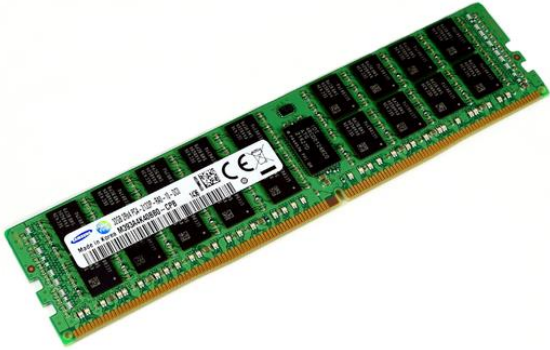
Peak간의 시간(ToF) = 26.0ps

코팅면의 두께

두께 = $26.0\text{ps(ToF)} / 2(\text{빛의 왕복}) * 0.3\text{mm/ps}(\text{빛의 속도}) / 1.6(\text{굴절률})$

두께 = 2.44mm





Bump가 있는 표면위의 몰딩 두께 측정

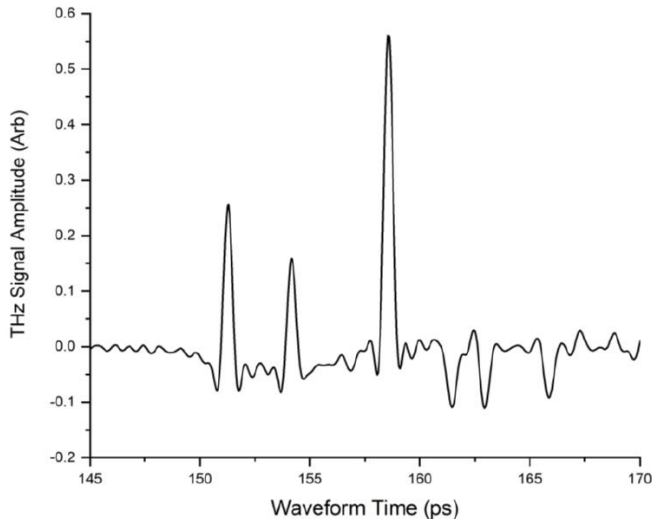
Peak1의 시간 = 151.3ps

Peak2의 시간 = 154.15ps

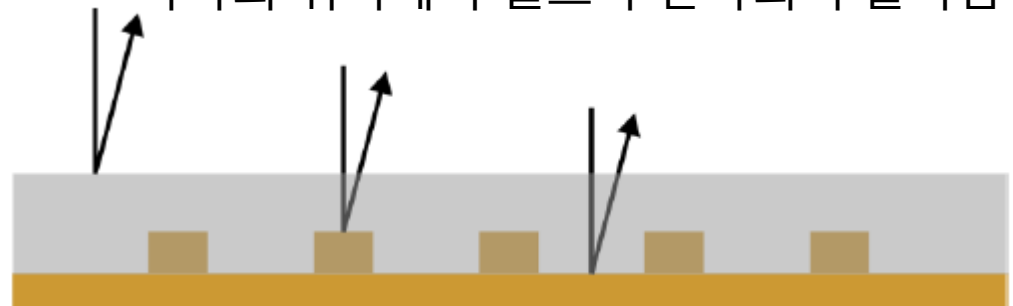
Peak3의 시간 = 158.55ps

몰드 표면부터 Bump까지의 두께 = 534.4um

몰드 표면부터 바닥면까지의 두께 = 1359.4um



스팟이 표면 구조에 비해 크기때문에
각각의 위치에서 펄스가 반사되어 돌아옴



자동차 범퍼 멀티레이어 코팅 측정

1. 클리어 코팅
2. 베이스 코팅

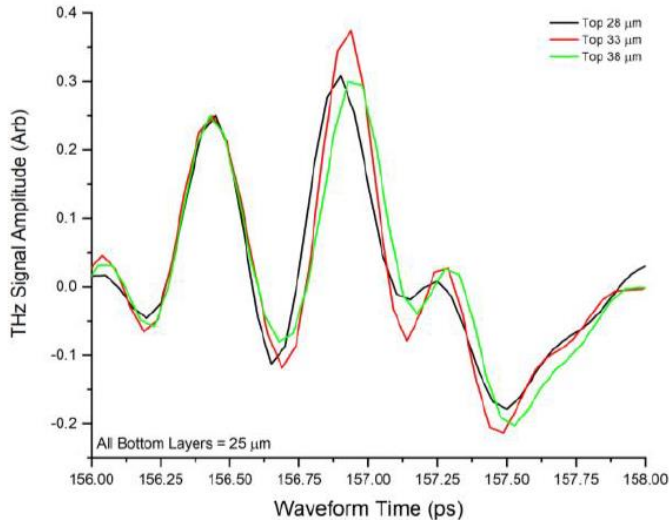
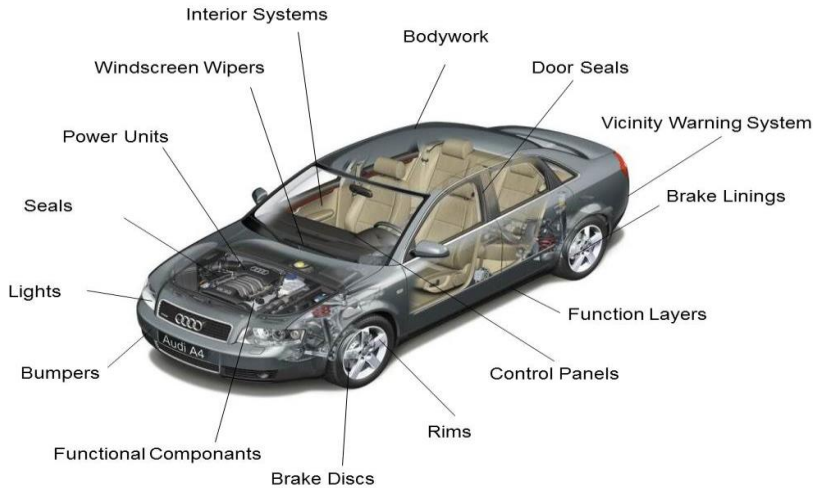


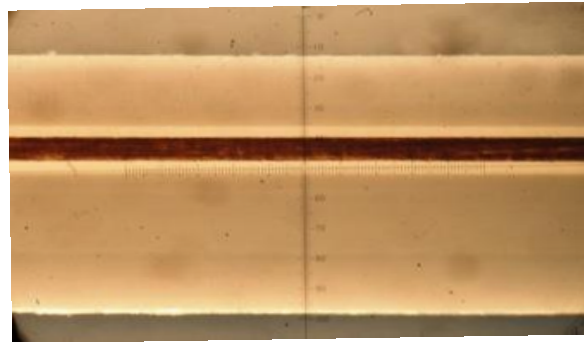
Table 1 - Listed and THz Measured Layer Thickness Value for Sample 3)

Sample	Listed Top Thk (μm)	Meas Top Thk (μm)	Difference (μm)	Listed Bot Thk (μm)	Meas Bot Thk (μm)	Difference (μm)
1	28	19.6	8.4*	35	34.1	0.9
2	38	38.1	-0.1	25	25.0	-0.0
3	38	37.9	0.1	35	36.2	-1.2
4	28	27.4	0.6	15	15.3	-0.3
5	33	34.0	-1.0	25	23.4	1.6
6	38	34.1	3.9*	15	14.8	0.2
7	33	31.5	1.5	35	37.0	-2.0
8	28	28.6	-0.6	25	24.6	0.4
9	33	37.7	-4.7*	15	15.0	0.0
		Ave	2.3		Ave	0.7
		if elim 3 pts*	0.7			

TERAMETRIX® Terametrix 적용 예

EVOH, Polypropylene 두께 측정

Polypropylene →
EVOH →
Polypropylene →



다층 플라스틱 압출물 단면도

