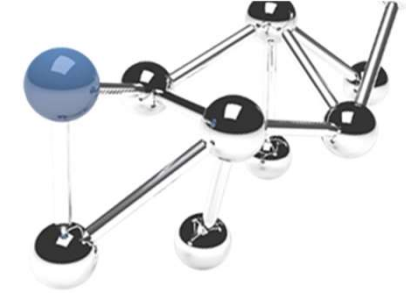


YUJIN Chemical

**New Active-Alignment Epoxy (YU-UETL1906)
Verification Result & Proposal**

Automotive Active-Alignment Epoxy Drawback & 개발목표



● Automotive Active-Alignment Process

: Dispense A/A Epoxy → Active Alignment → Positioning MTF Best & Optical Centering
→ Defocusing (Z-axis upward movement) → UV Cure → Thermal Cure (Oven Cure)

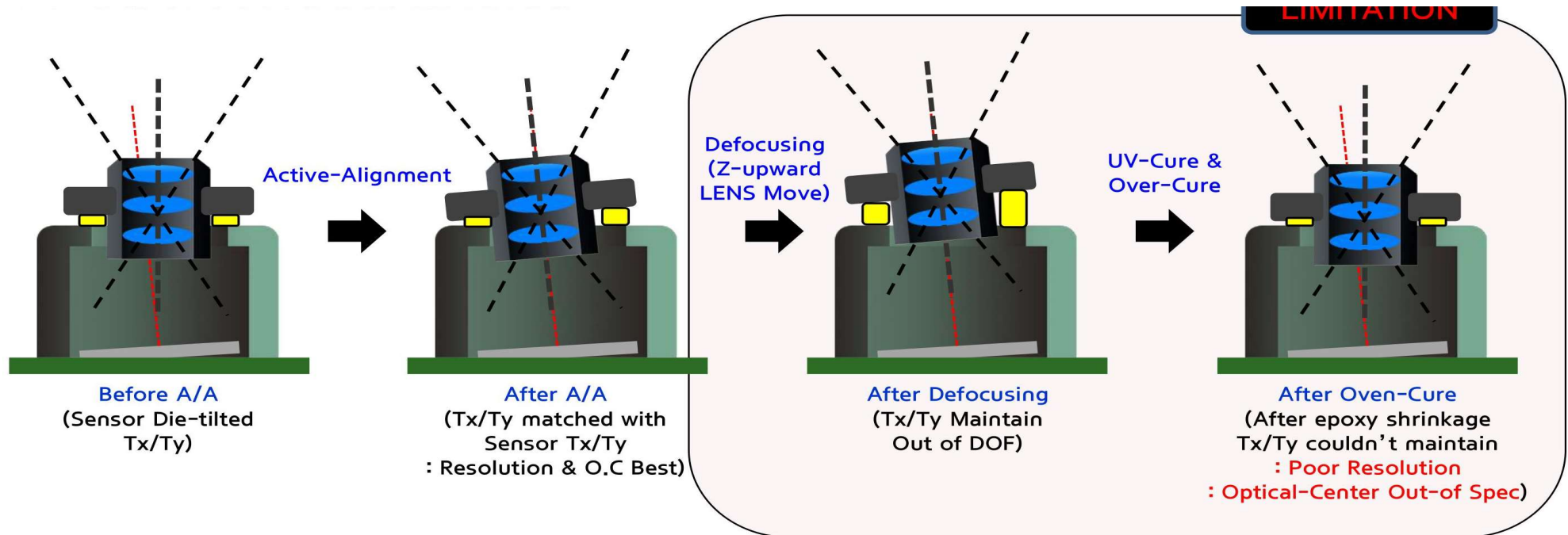
(Defocusing 공정 적용 불가피 사유 : 무거운 렌즈무게 및 열경화 후의 A/A Epoxy 수축을 보상하기 위해 임의로 렌즈위치를 상향조정)

● Previous limitation

1) Oven Cure 후, A/A Epoxy Shrinkage로 A/A-Best 의 Tilt X/Y 및 Position 유지가 어려움.

→ 기존 A/A Epoxy 들은 Oven Cure 과정에서 A/A-Best 조건의 Tilt X/Y를 유지하지 못함.

→ 이로 인해, 최적의 해상력 및 광축을 구현해내지 못함.



Automotive Active-Alignment Epoxy Drawback & 개발목표



● Previous limitation

2) 낮은 유리전이 온도(T_g : Glass Transition Temperature)로 환경에 의한 경시변화로 해상력 변화 유발

: T_g 가 일반 환경 조건 수준으로, 일부 온도 인가된 상태에서도 상변화가 유발되어 렌즈 위치를 변화시켜 결과적으로 해상력의 저하를 발생시킴

3) 높은 열 팽창율로 고온/저온 상태에서 Epoxy 두께가 변화하여 고온/저온 상태에서 해상력 성능 불만족

: $-40\sim 105^\circ\text{C}$ 의 Operating Temperature 구간에서 전체적으로 해상력을 유지/SPEC-IN 이어야 하는 AUTOMOTIVE Camera에서 기존 Epoxy의 상대적으로 높은 열팽창율로 15um까지 팽창/수축을 발생시키면서 렌즈의 초점거리를 벗어나 해상력 저하를 발생시킴

4) 50kgf 전후의 접착력으로 충격에 따른 신뢰성이 낮음.



고화소, 높은 해상력, 높은 신뢰성 확보가 필요한 자동차 카메라 시장의 트렌트에 대응하기 위해 상기 주요 4가지의 현재 Active-Alignment Epoxy의 약점을 보완한 개선된 Epoxy가 절실히 필요한 상황으로 개발 착수 근거

■ New A/A Epoxy(GT-UETL1906) Test – Assessment Result Summary



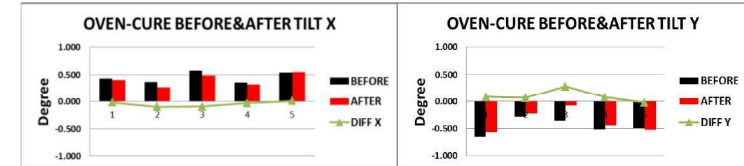
Pros. & Cons. Compared with AS-IS Delo-LT3480

ADVANTAGE

RESOLUTION ASPECT

1. POSTURE MAINTENANCE

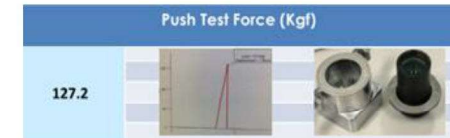
- Higher Tg Temp.
- State(Phase) maintenance power is strong
- Could maintain A/A final best MTF posture even after thermal cure.
- Could make best MTF & Zero-Aligned Optical Center Image Module.



HARDNESS ASPECT

2. ADHESION FORCE

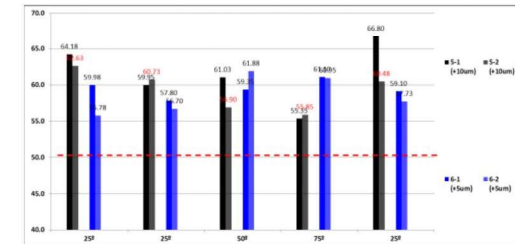
- Big improved, doubled adhesion force → 130kgf (internal spec ≥ 60kgf, LT3480 Avg 65kgf)
- Could be a robust countermeasure action for detaching issue of Lens.



RESOLUTION ASPECT

3. THERMAL EXPANSION

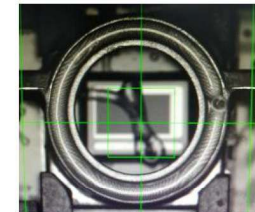
- Room Temp. to 100°C, thermal expansion is lower. (6.9um / compared with 10.6um of LT3480)
- Could improve MTF vs Temp. phenomenon.
- **Mobileye Qualification Proceed**



MANUFACTURE ASPECT

4. PRODUCTIVITY

- Convenient to use
- Have proper Viscosity & Thixotropic-Index to dispense, PR Detect well, Longer working time (Less phase transition)



RELIABILITY STABILITY



● Reliability Test Result (Image-Module Internal)

- Thermal Shock 500 Cycle → Resolution Pass
- Further test will be. (High&Low Temp, High Temp&Humidity Test)

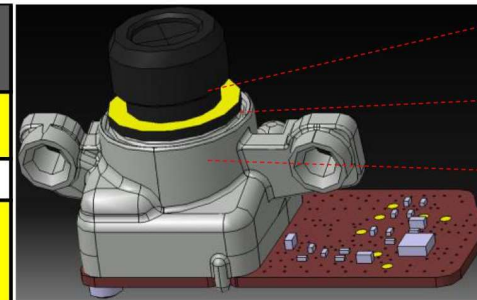
■ New A/A Epoxy(GT-UETL1906) Test – Datasheet Review



■. A/A EPOXY PROPERTIES COMPARISON (With AS-IS)

Name		DELO-DUALBOND LT3480	YUJIN YU-UETL1906	
Suitable materials		PC, FR4, PBT, Aluminium	PC, LCP, Ceramics, Glass, Aluminium	
Curing type		UV + Heat	UV + Heat	
Cure Condition		1-5sec @ 365nm 60mW/cm2 (320~450nm)	365nm, 2,500mJ/cm ²	
		30min @ 80°C	30min @ 80°C	
		Density @ 25 °C		1.25
Before curing	Type	mCD	modified Epoxy	
	Color	beige	Cloudy	
	Viscosity(mPas)	95,000	50,000 (cPs)	
After curing	Tg		35 °C (TMA)	86.3°C (DMTA)
	CTE [ppm]	Tg >	85 ppm/K	100.08 ppm/C
		Tg <	185 ppm/K	163.9 ppm/C
Young's modulus(MPa)		1000	1690	
Hardness (Shore D)		77	72	
Elongation %		20	-	
Shrinkage(volume), %		2.56%	3% <	
Tensile Strength(MPa)		25	-	
CSS	AI/AI(MPa)	21	-	
Datasheet		 DELO-LT3480	 YU-UETL 1906	

■. THERMAL EXPANSION SIMULATION DATA



- ① LENS BARREL : CU CTE 19ppm/K
▶ (25~100°C) **13.82 um** [Based on F.F.I 9.7mm]
- ② AA EPOXY : DELO LT3480 CTE 185ppm/K
▶ (25~100°C) **10.62 um** [Based on Nominal Gap 0.825mm]
- ③ LENS HOLDER : ALDC12 CTE 20.8ppm/K
▶ (25~100°C) **18.80 um** [Based on Height of 12.05mm]

SHRINKAGE	BEFORE TG	AFTER TG	TOTAL (um)
LT3480	0.701	9.921	10.622
UETL1906	5.061	1.852	6.914

MERIT **3.708**

□ UV Glue YU-UETL1906

■ 10cc x 10syringes



■ New A/A Epoxy(GT-UETL1906) Test – Dispensing Setting & Test



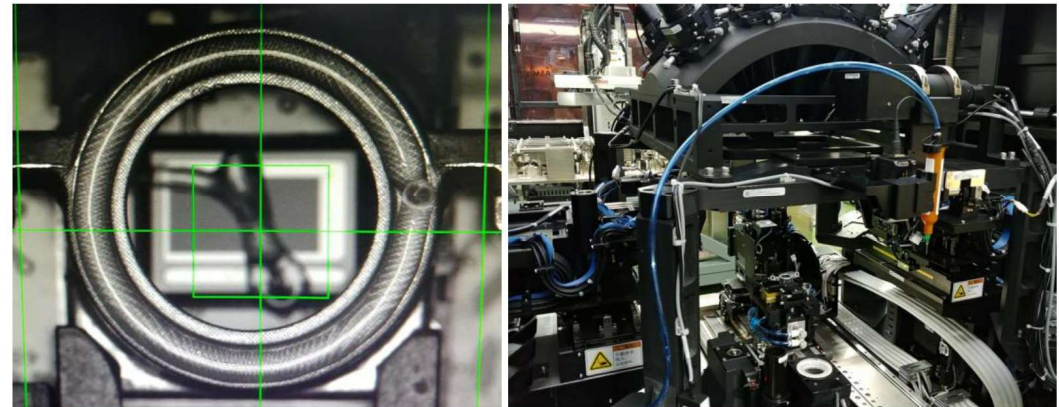
■ Initial Test : Dispense status check

- Glue weight : 80~85mg
- UV Cure Parameter (Follow AS-IS MFG condition)
 - UV Power : > 1000mW/cm²
 - UV Exposure time : 3 sec
- Oven Cure Parameter
 - Temperature : 100°C
 - Curing time : 45 min

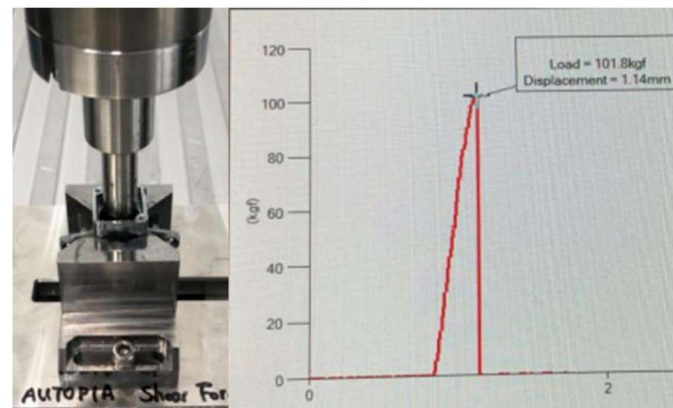


■ Dispense convenience → Good (Better to control)

■ Dispense shape / Area inspection → PR works good, No problem



■ Bond Force (with initial 84mg condition) : ~ 102 Kgf



■ New A/A Epoxy(GT-UETL1906) Test – Dispensing Setting & Test



■. Bonded Camera

- Before Push-Pull Test



■. After Push-Pull Test

- Bond Force : 102 Kgf (with 84mg Volume)



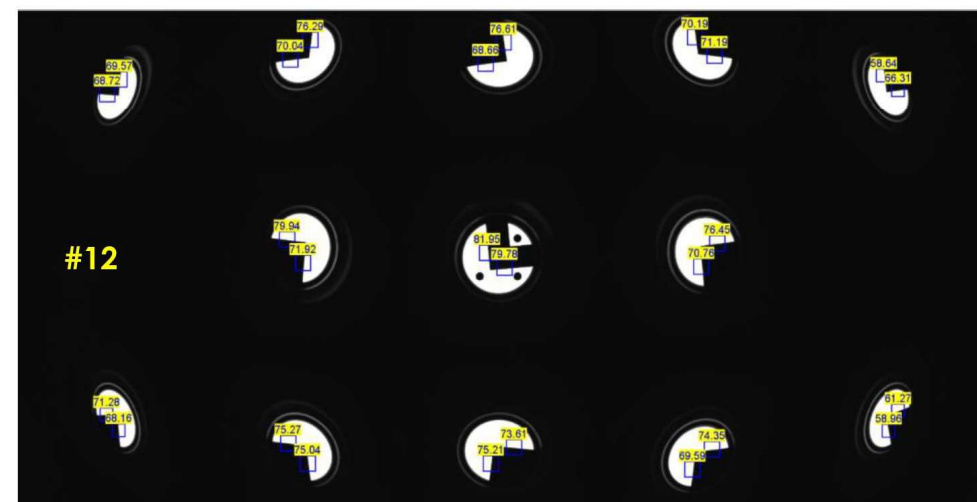
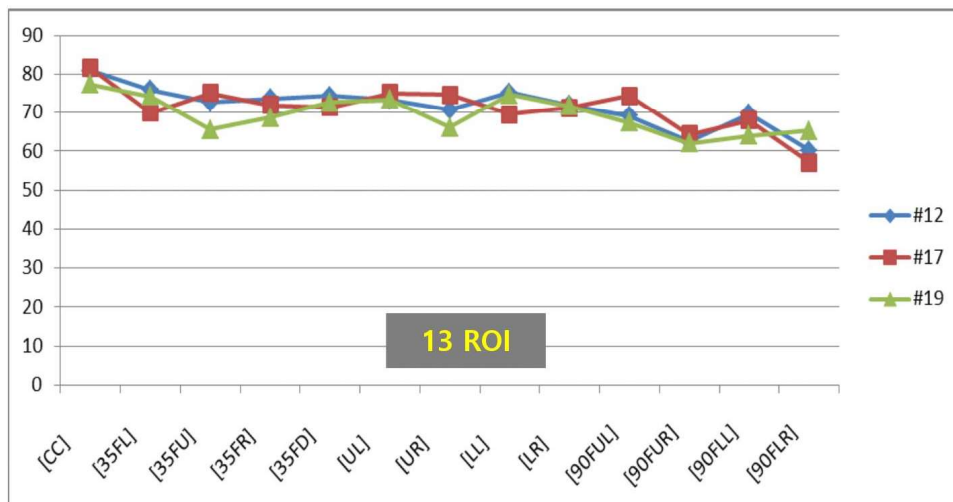
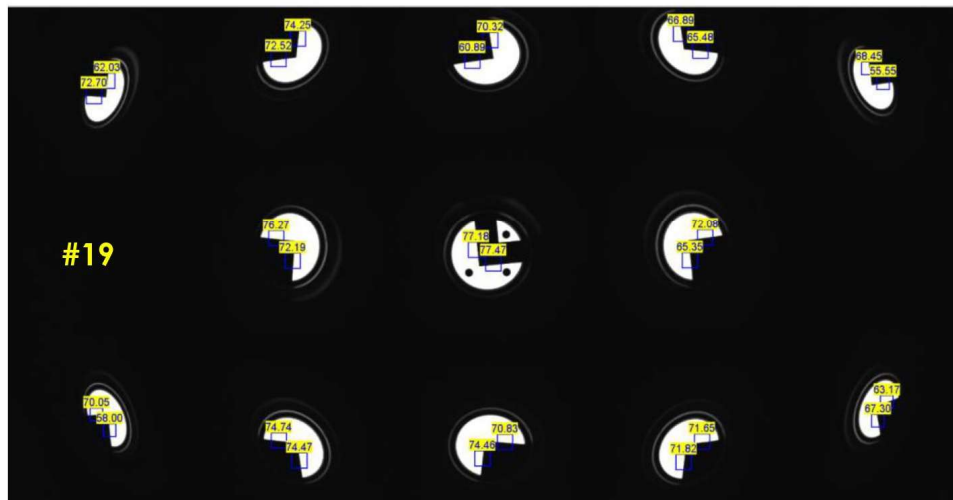
■ New A/A Epoxy Test – MTF Variation vs Time Transition(24hrs)



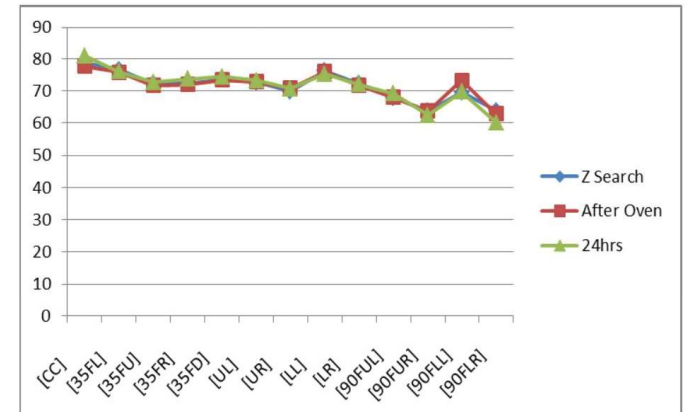
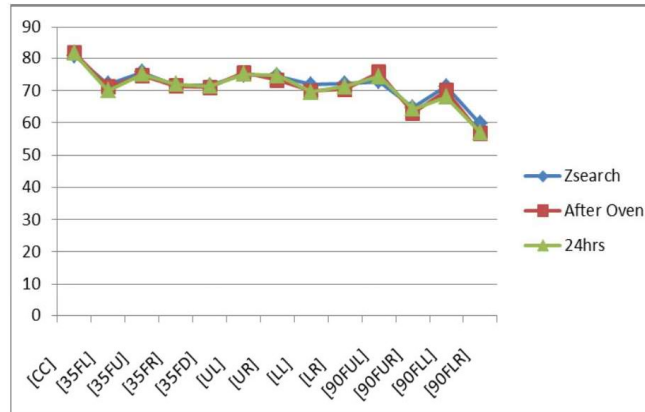
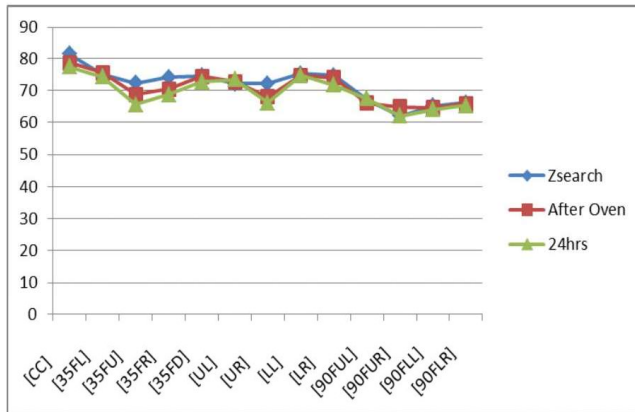
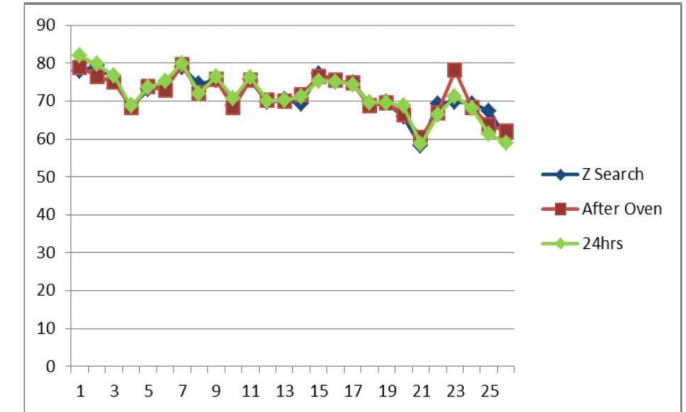
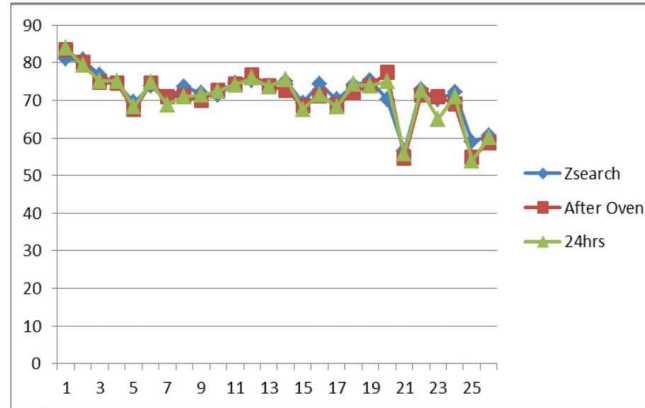
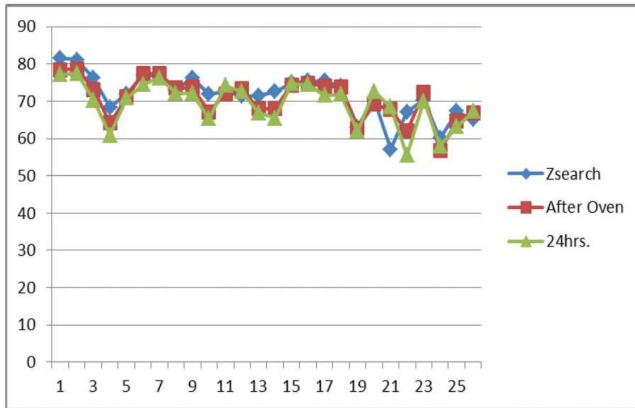
■. MTF Validation : MTF variation vs time transition (24hrs)

- Unit #19 : Glue wt: 105mg UV exposure: 3sec
- Unit #17 : Glue wt: 106mg UV exposure: 3sec
- Unit #12 : Glue wt: 105mg UV exposure: 3sec

□ The MTF scores are able to maintain the peak values even after 24 hrs.



■ New A/A Epoxy Test – MTF Variation vs Time Transition(24hrs)



→ Best MTF Maintained during 24hrs.

■ New A/A Epoxy Test – MTF Variation vs Time Transition(1week & 2week)



■. MTF Validation : MTF variation vs time transition (1 Week / 2 Weeks)

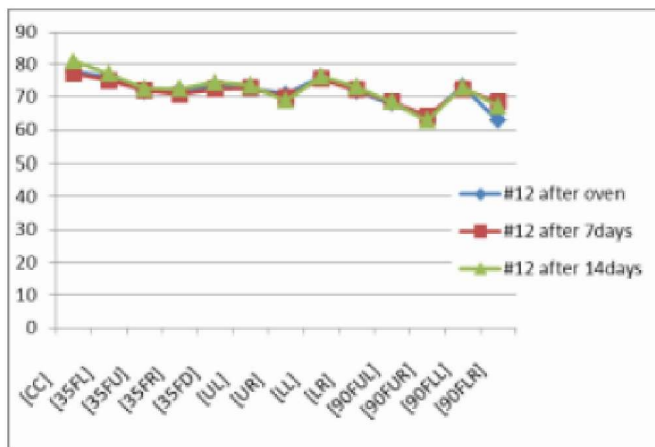
- Unit #19 : Glue wt: 105mg UV exposure: 3sec
- Unit #17 : Glue wt: 106mg UV exposure: 3sec
- Unit #12 : Glue wt: 105mg UV exposure: 3sec

□ The MTF scores are able to maintain the peak values **even after 2 Weeks.**

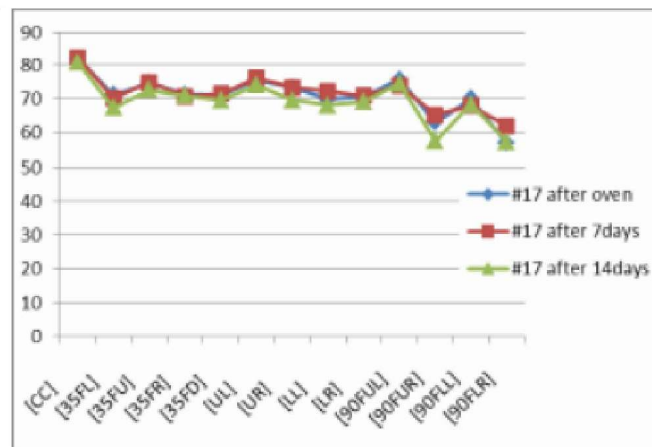
□ 13 ROI MTF Validation

After Oven		[CC]	[35FL]	[35FU]	[35FR]	[35FD]	[UL]	[UR]	[LL]	[LR]	[90FUL]	[90FUR]	[90FLL]	[90FLR]
#12 after oven		78	76	72	72	73	73	71	76	72	68	64	73	63
#17 after oven		82	71	75	71	71	75	73	70	70	76	63	70	57
#19 after oven		79	75	69	70	74	73	68	75	74	66	65	65	66
After 7days		[CC]	[35FL]	[35FU]	[35FR]	[35FD]	[UL]	[UR]	[LL]	[LR]	[90FUL]	[90FUR]	[90FLL]	[90FLR]
#12 after 7days		77	75	72	71	72	73	70	75	72	68	64	72	68
#17 after 7days		82	70	75	71	71	76	73	72	71	74	65	68	62
#19 after 7days		77	73	66	68	75	73	66	74	71	66	62	65	69
After 14days		[CC]	[35FL]	[35FU]	[35FR]	[35FD]	[UL]	[UR]	[LL]	[LR]	[90FUL]	[90FUR]	[90FLL]	[90FLR]
#12 after 14days		81	77	73	72	74	73	69	76	73	69	63	73	67
#17 after 14days		81	67	73	71	70	74	69	68	69	75	57	68	57
#19 after 14days		79	74	70	71	75	72	70	74	72	66	66	65	69

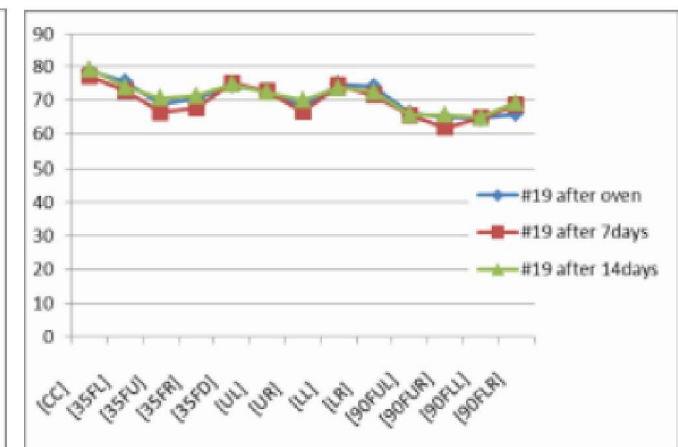
Unit # 12



Unit # 17



Unit # 19



■ New A/A Epoxy Test – MTF Variation vs Time Transition(1week & 2week)



■. MTF Validation : MTF variation vs time transition (1 Week / 2 Weeks)

- Unit #19 : Glue wt: 105mg UV exposure: 3sec
- Unit #17 : Glue wt: 106mg UV exposure: 3sec
- Unit #12 : Glue wt: 105mg UV exposure: 3sec

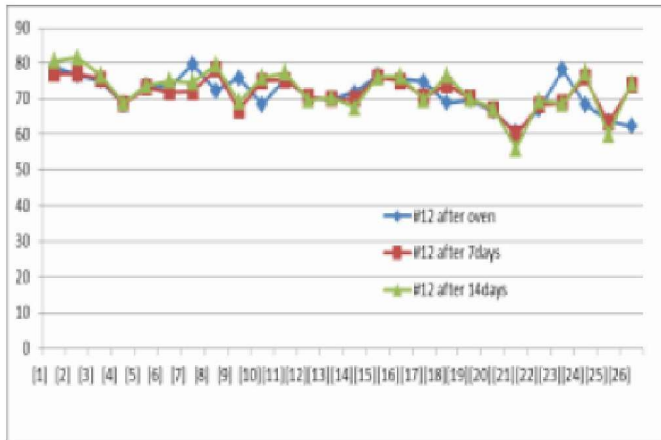
□ The MTF scores are able to maintain the peak values **even after 2 Weeks.**

→ Further time transition will be checked till after 3 weeks.

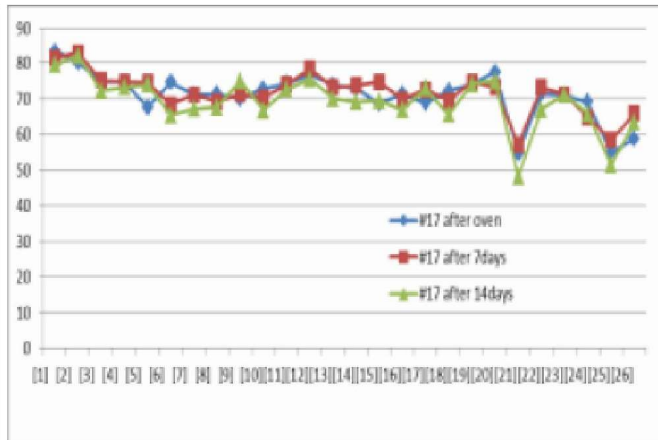
□ 26 ROI MTF Validation

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]
#12 after oven	79	77	75	68	74	73	80	72	76	68	75	70	70	72	76	75	75	69	70	66	60	67	78	68	64	62
#17 after oven	83	80	75	75	68	74	71	71	70	73	74	77	74	73	69	71	69	72	74	77	55	71	71	69	55	59
#19 after oven	78	79	73	64	71	77	77	73	74	67	72	73	68	68	74	75	74	74	63	69	68	62	72	57	65	67
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]
#12 after 7days	77	77	75	68	73	72	72	78	67	75	75	70	70	70	76	75	70	74	70	67	60	68	69	76	63	74
#17 after 7days	81	83	75	75	74	68	71	69	71	70	74	78	73	74	75	70	72	69	75	73	57	73	71	65	58	66
#19 after 7days	78	77	71	62	77	73	69	76	64	71	73	73	68	65	74	74	72	71	64	67	66	58	57	73	69	68
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]	[26]
#12 after 14days	80	82	77	69	74	75	74	79	69	76	77	70	70	68	76	76	70	76	70	67	56	69	69	77	60	74
#17 after 14days	79	82	72	73	74	65	67	67	75	67	73	75	70	69	69	67	73	65	74	75	48	67	71	66	51	63
#19 after 14days	79	80	75	66	75	74	72	76	69	73	72	73	71	70	75	73	72	73	61	70	67	65	58	71	68	70

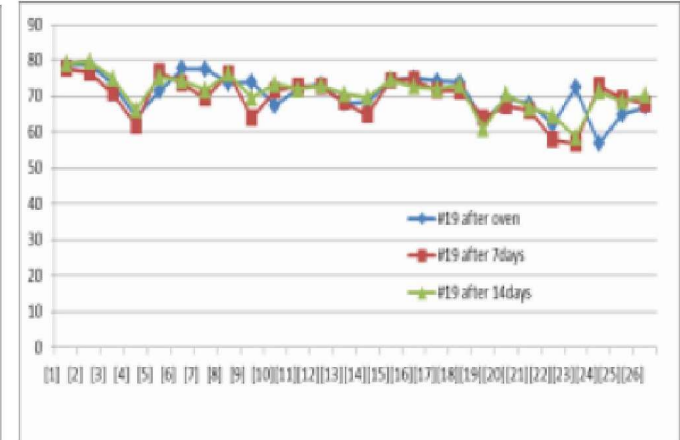
Unit # 12



Unit # 17



Unit # 19



■ New A/A Epoxy Test – MTF Variation vs Time Transition(3week)

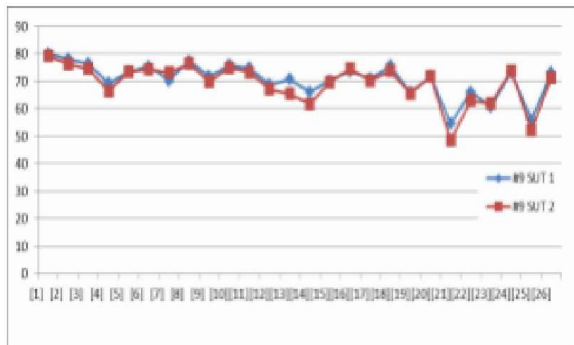


□ Final parameter x 10 units

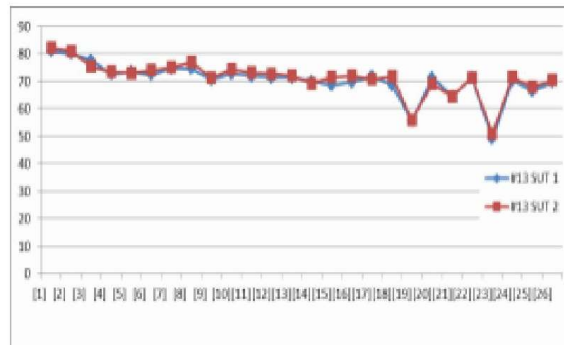
- Qty: x10 bonded camera ; with final parameter ; bonded 7Aug
- Parameter : Glue wt: 106mg;

□ MTF check : After 20 days x10 units : SUT 1 & SUT 2 comparison (26Aug)

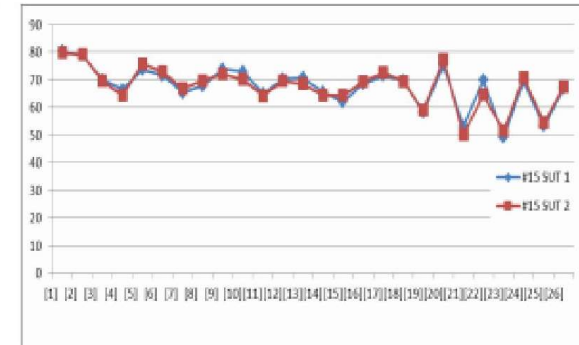
#9



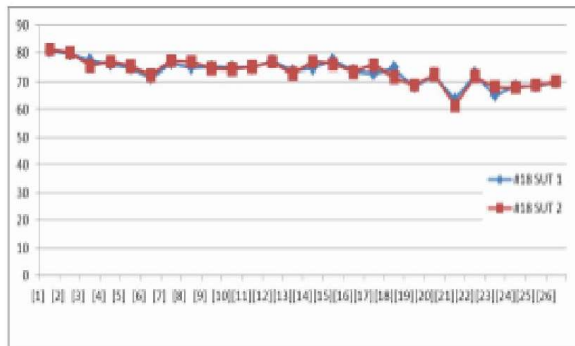
#13



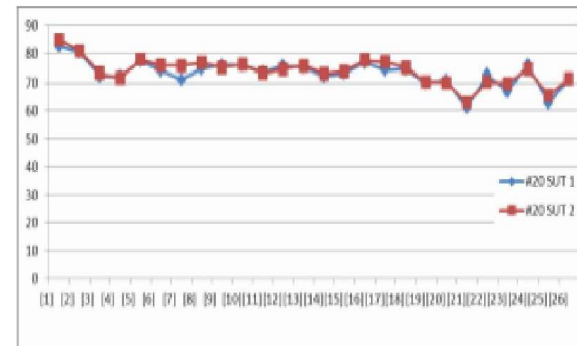
#15



#18

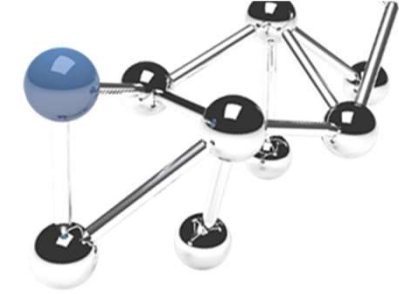


#20



□ The shape trend of MTF scores of all ROI are the same between the 2 SUTs after 20days

■ New A/A Epoxy Test – MTF Variation vs Time Transition(3week)

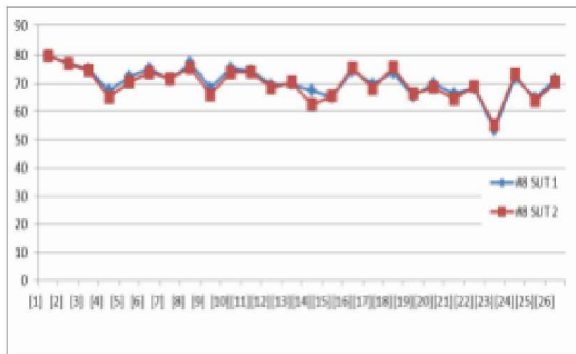


□ Final parameter x 10 units

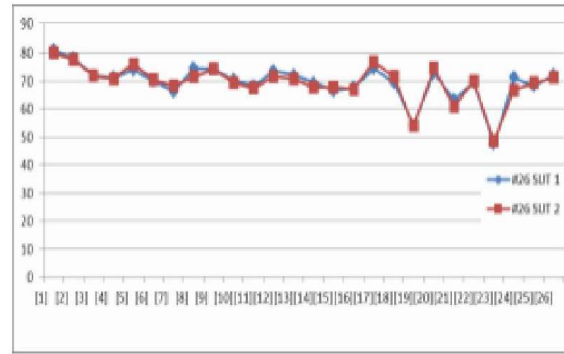
- Qty: x10 bonded camera ; with final parameter ; bonded 7Aug
- Parameter : Glue wt: 106mg

□ MTF check : After 20 days x10 units : SUT 1 & SUT 2 comparison (26Aug)

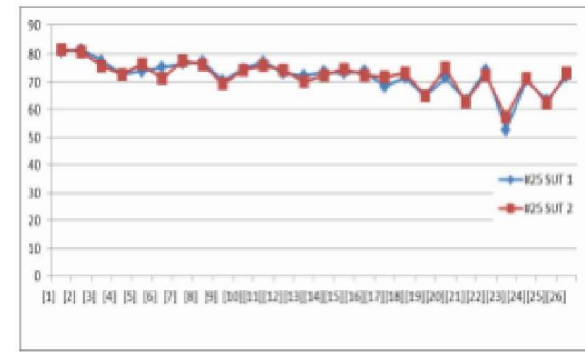
#8



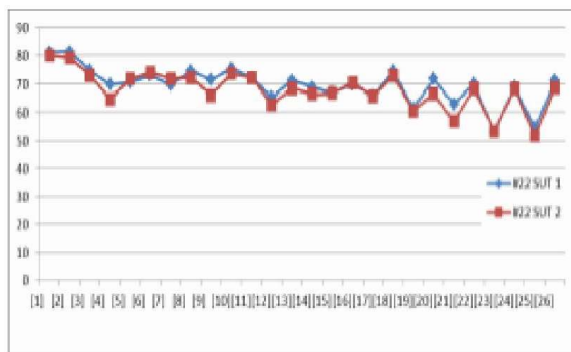
#26



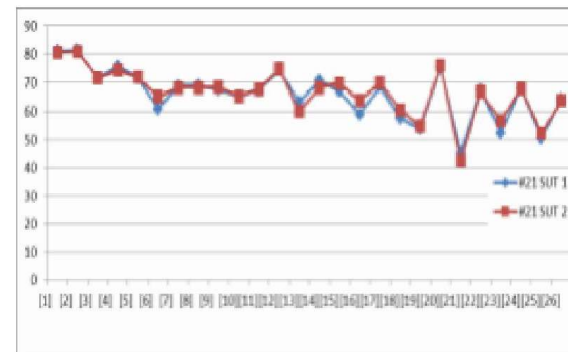
#25



#22



#21



□ The shape trend of MTF scores of all ROI are the same between the 2 SUTs after 20days

■ New A/A Epoxy Test – Adhesion Strength Validation



■. Push-Pull Test : Epoxy adhesion force result with Exp.time & Epoxy volume (After 24hrs)

Test #	Pair #	Glue Wt. (mg)	Push Test Force (Kgf)
1	28	85	88.2
2	11	104	99.9
3	7	105	103.9
4	27	106	127.2



Exceptionally Better than Delo-LT3480.

AS IS : DELO LT3480 Adhesion Force

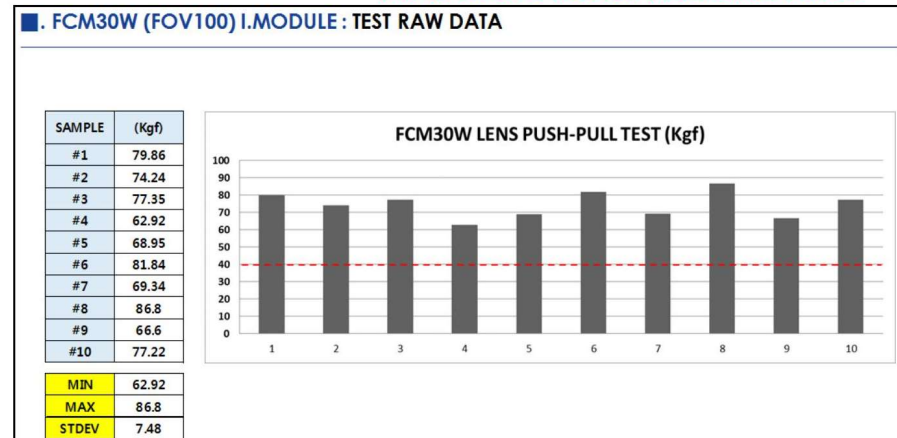
→ The adhesion force is higher at epoxy weight of 100mg than 85mg.

About 130 Kgf

Compare with As-Is Delo LT3480 Epoxy : **Almost Doubled**

(Delo LT3480 : Avg 70 Kgf)

x 2

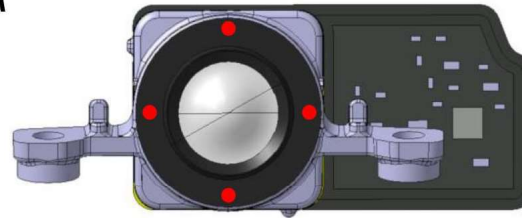
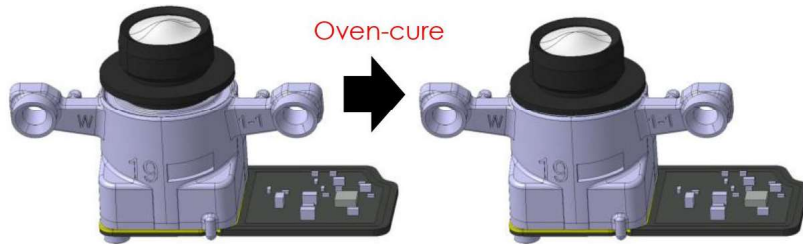


■ New A/A Epoxy Test – Posture Maintenance Ability ★ ★ ★



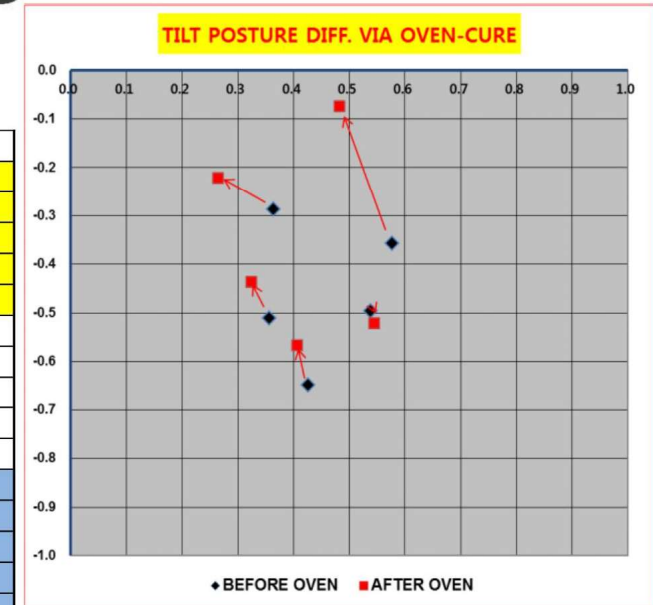
■ Posture (Lens height) difference check with CMM

- Defocus value : ~40um @ epoxy weight ~105mg

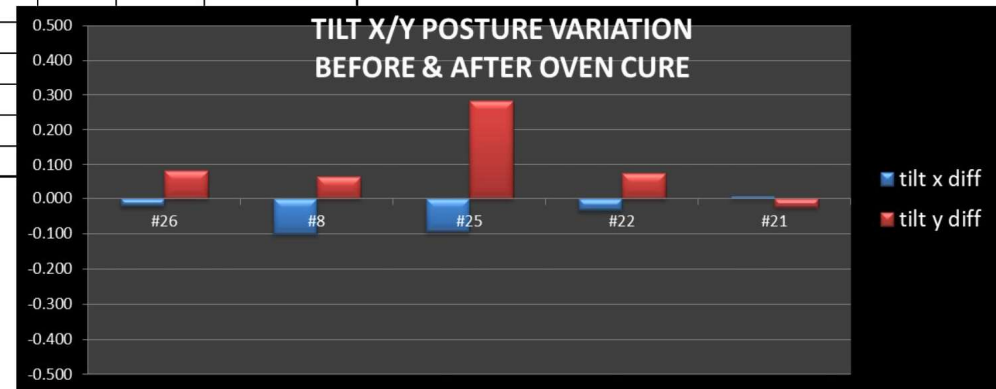


- Lens Barrel Wing Top 4-Point Height Measurement

Exceptionally Better than Delo-LT3480.



S/N	SPECIFICATIONS	INSP INSTR	26	8	25	22	21			REMARKS
1	DISTANCE xr	CMM	17.703	17.687	17.656	17.658	17.671			After UV MORNING
2	DISTANCE yt	CMM	17.548	17.601	17.530	17.540	17.529			MORNING
3	DISTANCE xl	CMM	17.592	17.594	17.497	17.567	17.525			MORNING
4	DISTANCE yb	CMM	17.733	17.673	17.621	17.677	17.661			MORNING
5	PARALLELISM // 0.01 DATUMA	CMM	0.170	0.092	0.147	0.137	0.144			MORNING
	diff x		0.111	0.093	0.159	0.091	0.146	$ xr - xl $		
	diff y		-0.185	-0.072	-0.091	-0.137	-0.132	$ xt - xb $		
	tilt x		0.427	0.364	0.577	0.357	0.539	$ATAN((diff x/14)*(180/3.14))$		
	tilt y		-0.648	-0.287	-0.357	-0.511	-0.496	$ATAN((diff y/14)*(180/3.14))$		
1	DISTANCE xr	CMM	17.664	17.655	17.615	17.627	17.638			After Oven AFTERNOON
2	DISTANCE yt	CMM	17.530	17.595	17.544	17.529	17.495			AFTERNOON
3	DISTANCE xl	CMM	17.559	17.589	17.487	17.545	17.490			AFTERNOON
4	DISTANCE yb	CMM	17.685	17.650	17.562	17.643	17.635			AFTERNOON
5	PARALLELISM // 0.01 DA TUMA	CMM	0.197	0.078	0.128	0.102	0.155			AFTERNOON
	diff x		0.105	0.066	0.128	0.082	0.148			
	diff y		-0.155	-0.055	-0.018	-0.114	-0.140			
	tilt x		0.406	0.264	0.483	0.324	0.545			
	tilt y		-0.566	-0.222	-0.074	-0.437	-0.521			
	tilt x diff		-0.021	-0.100	-0.094	-0.033	0.006			
	tilt y diff		0.083	0.065	0.283	0.074	-0.025			

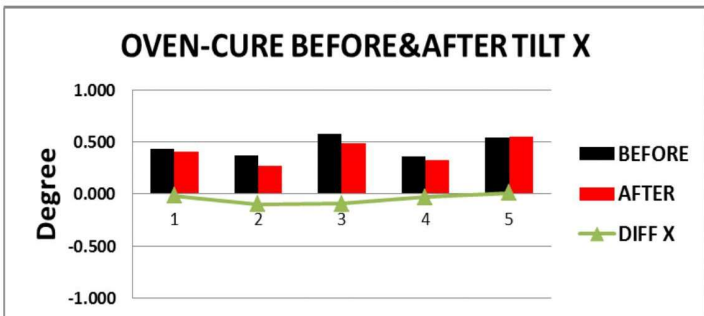
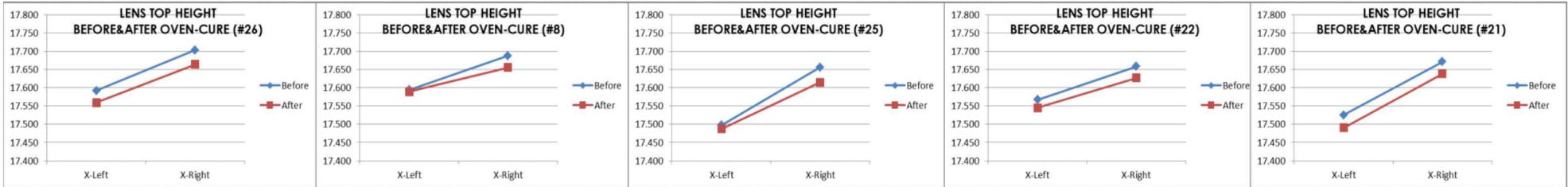


- Posture maintenance ability is very good.
- Maintain tilt direction.
- Tilt x/y change is a few (Before & After oven-cure)

■ New A/A Epoxy Test – Posture Maintenance Ability ★ ★ ★



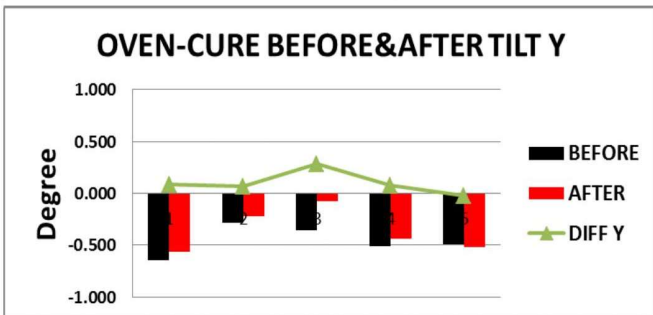
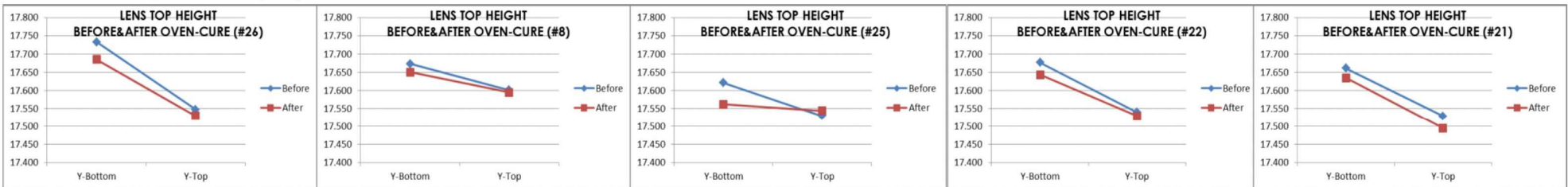
■. Posture (Lens height) difference : X-Axis



Posture maintained very well.

Exceptionally Better than Delo-LT3480.

■. Posture (Lens height) difference : Y-Axis



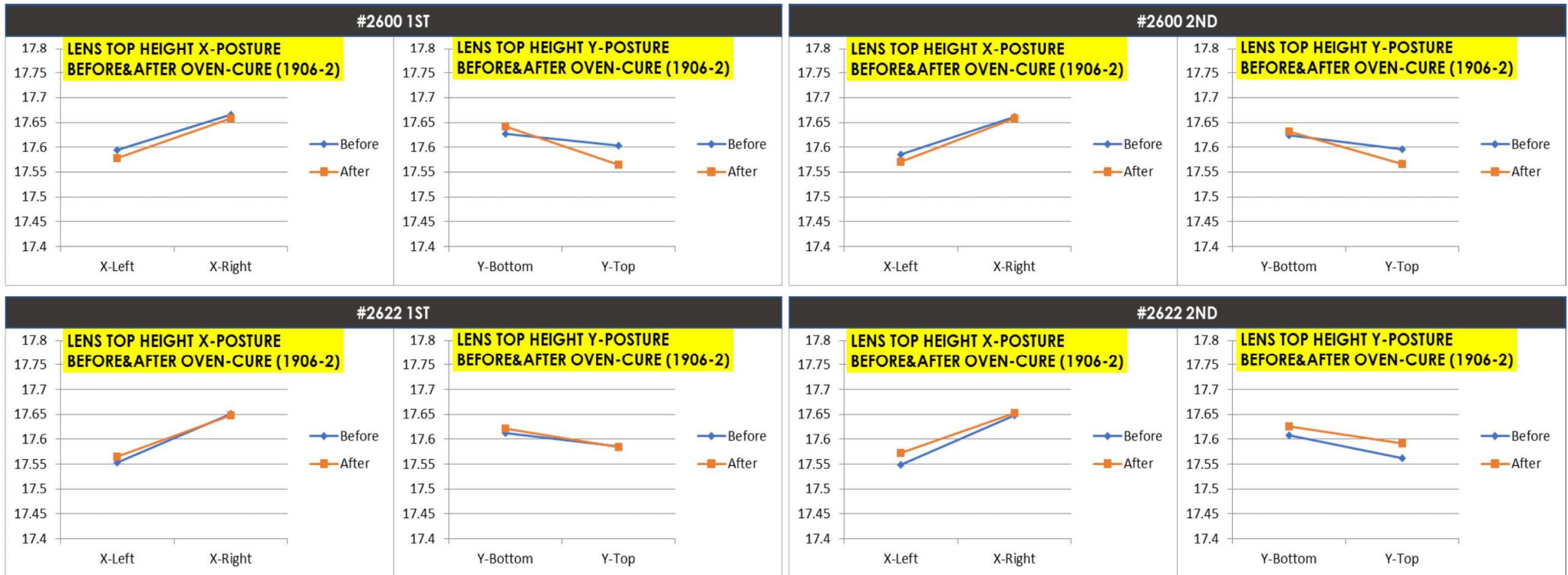
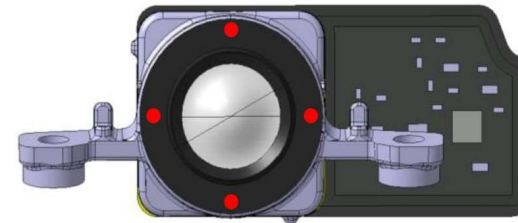
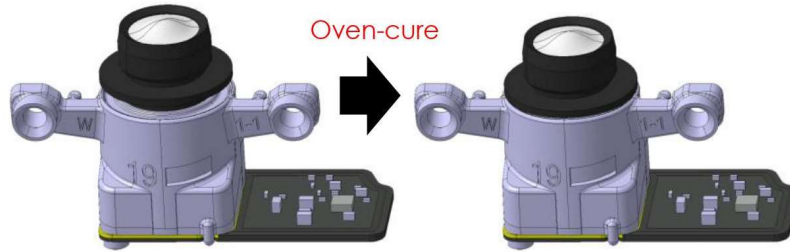
Posture maintained very well.

Exceptionally Better than Delo-LT3480.

■ New A/A Epoxy Test – Posture Maintenance Ability ★ ★ ★

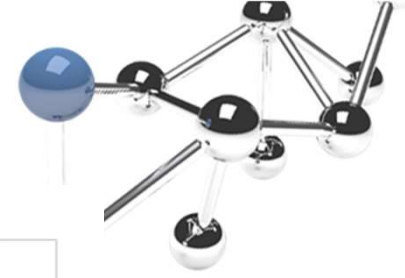


● Posture (Lens height) difference check with CMM

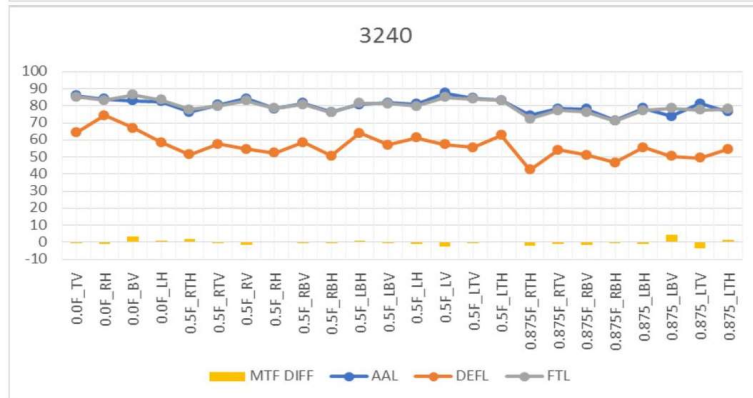
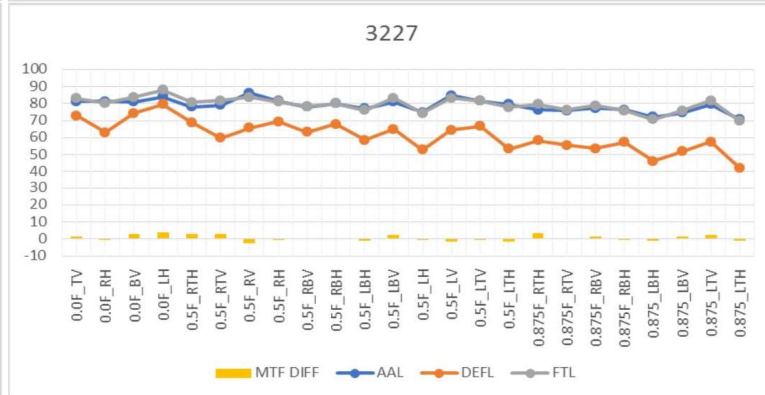
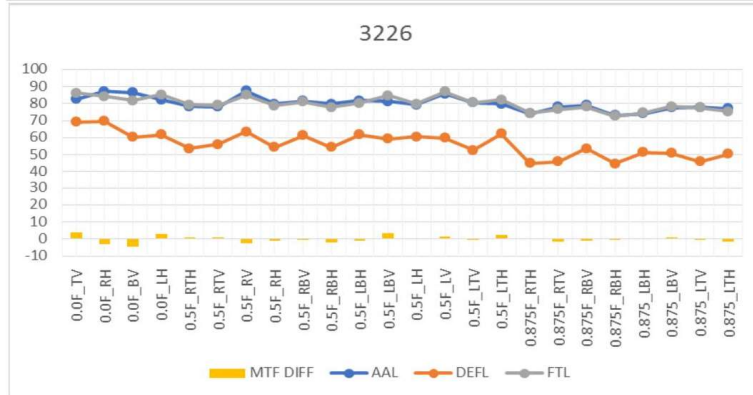
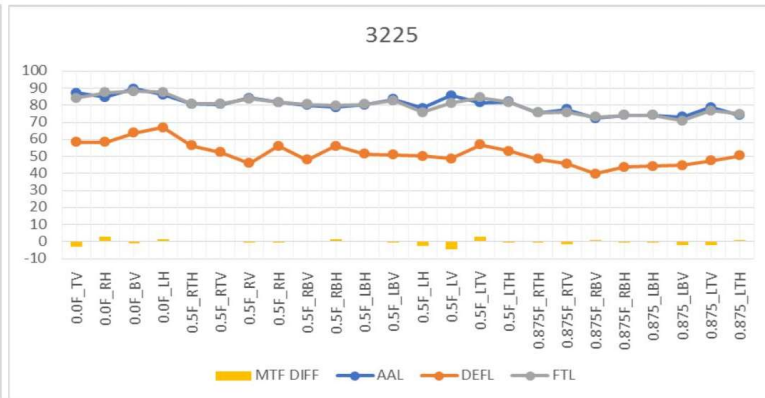
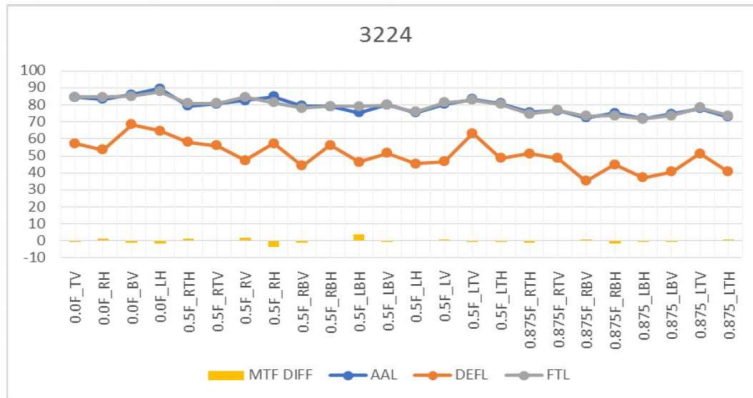


- Posture maintenance ability is very good.
- Maintain tilt direction. (Tilt x/y change is a few)

AA to FT MTF RESOLUTION & ADHESION FORCE : GT-UETL1906

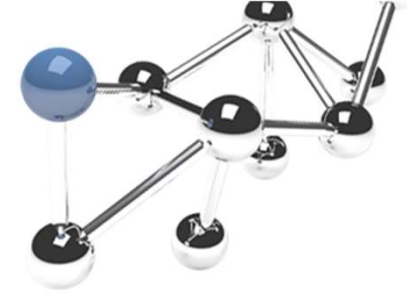


+25um Defocusing Applied (Based on Through-Focusing Data)

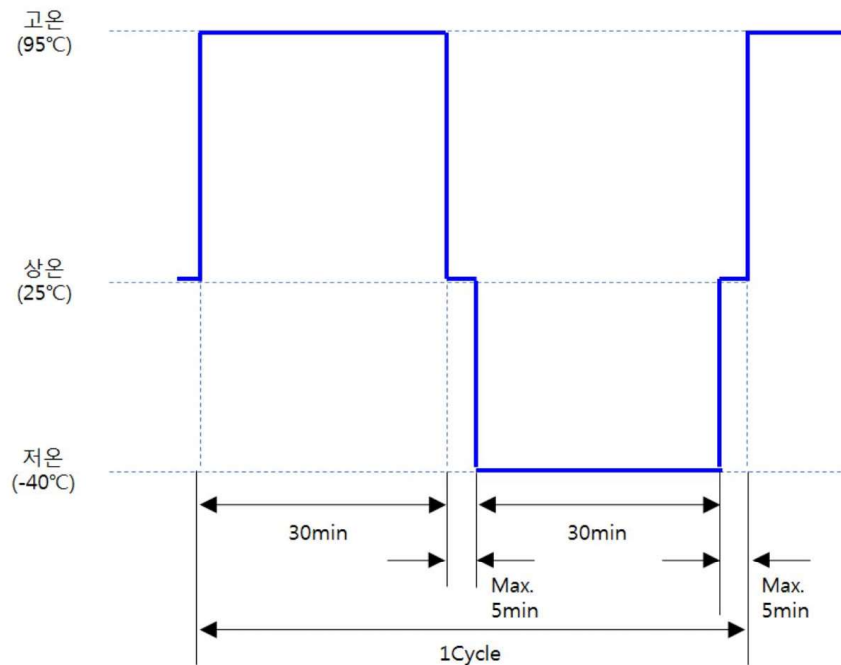


- AA to FT : Re-positioning status is good
- Epoxy could support Lens-Ass'y fully by UV-Cure.

AA to FT MTF RESOLUTION & ADHESION FORCE : GT-UETL1906



● Thermal Shock Test



-40°C ↔ 95°C

New A/A Epoxy applied
FCM30W 10EA Sample (made in ASM Singapore)
→ **Thermal Shock Test (Worst reliability test on Epoxy)**

-. Measure MTF Before & After
(After value should be measured after 24hours on dwell at room temperature)

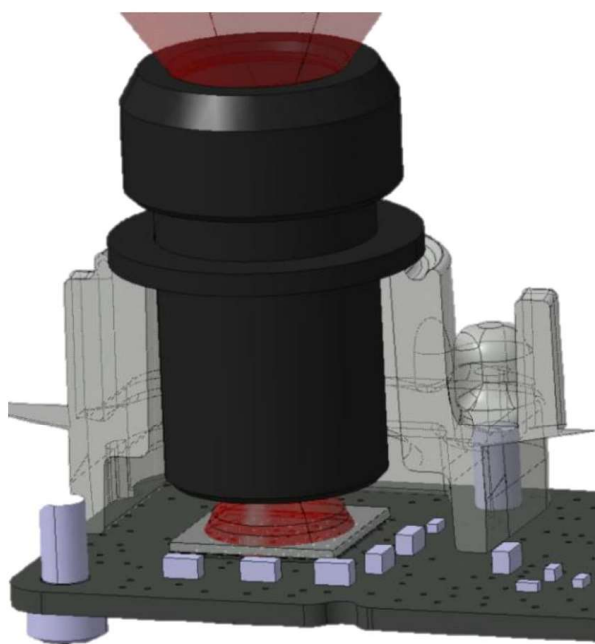
1) After 96 Cycle

2) After 500 Cycle (HKMC ES Spec Based)

HIGH TEMP. MTF IMPROVEMENT – OVERALL COMPENSATION

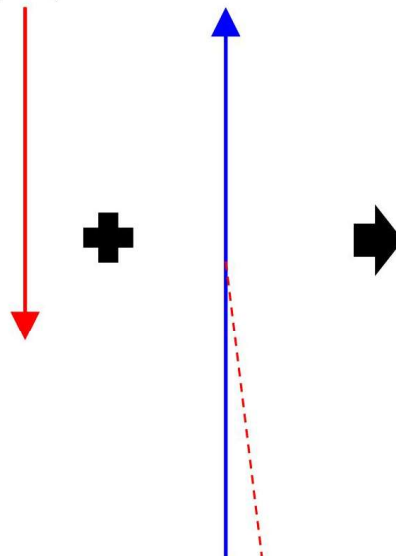


AS-IS Ver. [OVERALL VARIATION] (Combine with Optical & Mechanical Variation)



Optical Variation (E.F.L.)

Thermal Expansion

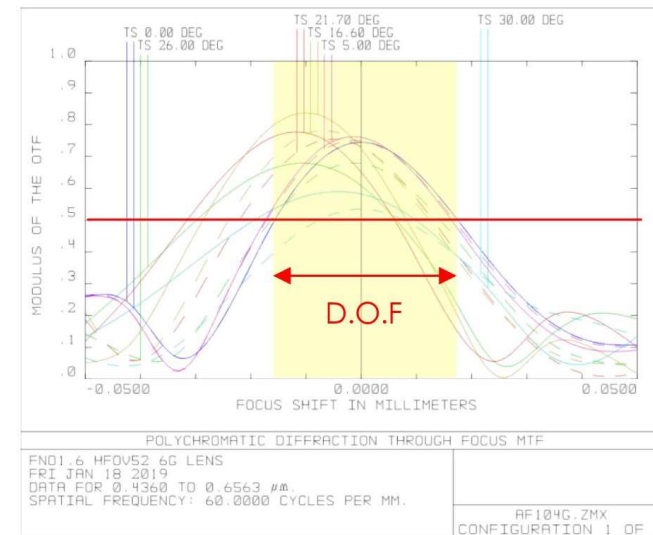


Upward change on Thermal Expansion
&
Downward change on LENS E.F.L

→ Compensation occur for Best-Focus Height
(Around 22um's position difference with 25°C & 75°C)
→ Out of D.O.F (Depth of focus) with Temperature Change

TO-BE Ver.

1. NEW EPOXY APPLIED (YUJIN)
 - : Decrease Thermal Expansion -4um
 - : Could be covered with Room Temp. & 75°C within D.O.F
2. NEW EPOXY + NEW LENS-HOLDER MATERIAL APPLIED
 - : Decrease Thermal Expansion -7um
 - : Could be covered with Room Temp. & 75°C within D.O.F



최종, YUJIN A/A EPOXY 로 변경 후 : 모바일이 저온/고온 MTF TEST PASS. (Confirmation from Mobileye)

■ 기술가치 : 분산 안정 제조공정 및 양이온 기반 조성물 특허출원증 : YU-UETL1906



평가결과 요약표

가치 평가액	236 백만 원				
사업화 제품	접착제				
사업화 단계	<input type="checkbox"/> 아이디어 <input type="checkbox"/> 연구개발 <input type="checkbox"/> 시제품제작 <input type="checkbox"/> 제품화 <input checked="" type="checkbox"/> 판매				
산업기술분류	400110 접착제/실란트	표준산업분류	C20493 접착제 및 젤라틴 제조업		
평가대상 IP	명칭				
	분산 안정성이 향상된 고점도 접착제의 제조방법				
	출원번호	출원일	발명자		
	10-2022-0123086	2022.09.28.	권은진		
평가 용도	기술거래				
사업화 주체	㈜유진케미칼 (사업자등록번호 : 605-86-24849)				
평가 방법	로열티공제법(모델 1)				
평가 기준일	2022.09.30.	평가 기간	2022.09.30. ~ 2022.10.20.		
경제적 유효 수명	10.58년	보고서 유효기간	2022.10.20. ~ 2023.10.19.		
현금흐름 추정기간	2022.09.30. ~ 2033.04.28. (10.58년)				
할인율	자기자본비용	타인자본비용	자기자본비용	WACC	
	15.37%	7.2%	63.63%	12.11%	
로열티율	기준 로열티율	이용률	개척률	증감률	최종 로열티율
	3.00%	97.5%	100.0%	130.0%	3.80%

평가결과 요약표

가치 평가액	236 백만 원				
사업화 제품	듀얼 경화형 고점도 접착제				
사업화 단계	<input type="checkbox"/> 아이디어 <input type="checkbox"/> 연구개발 <input type="checkbox"/> 시제품제작 <input type="checkbox"/> 제품화 <input checked="" type="checkbox"/> 판매				
산업기술분류	400110 접착제/실란트	표준산업분류	C20493 접착제 및 젤라틴 제조업		
평가대상 IP	명칭				
	유리전이 온도가 향상된 듀얼 경화형 고점도 접착제 조성물				
	출원번호	출원일	발명자		
	10-2022-0123087	2022.09.28.	권은진		
평가 용도	기술거래				
사업화 주체	㈜유진케미칼 (사업자등록번호 : 605-86-24849)				
평가 방법	로열티공제법(모델 1)				
평가 기준일	2022.09.30.	평가 기간	2022.09.30. ~ 2022.10.20.		
경제적 유효 수명	10.35년	보고서 유효기간	2022.10.20. ~ 2023.10.19.		
현금흐름 추정기간	2022.09.30. ~ 2033.02.03. (10.35년)				
할인율	자기자본비용	타인자본비용	자기자본비용	WACC	
	15.37%	7.2%	63.63%	12.11%	
로열티율	기준 로열티율	이용률	개척률	증감률	최종 로열티율
	3.00%	93.1%	100.0%	137.5%	3.84%



THANK YOU