

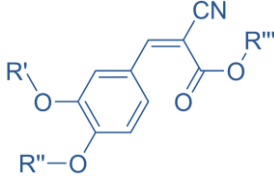
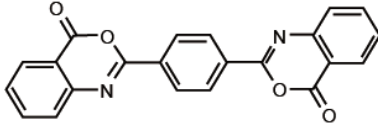
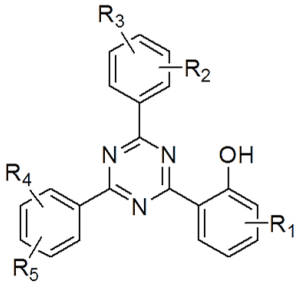
Chiguard[®] GA403

A Highly Effective **UV Blocker** Derived from Nature

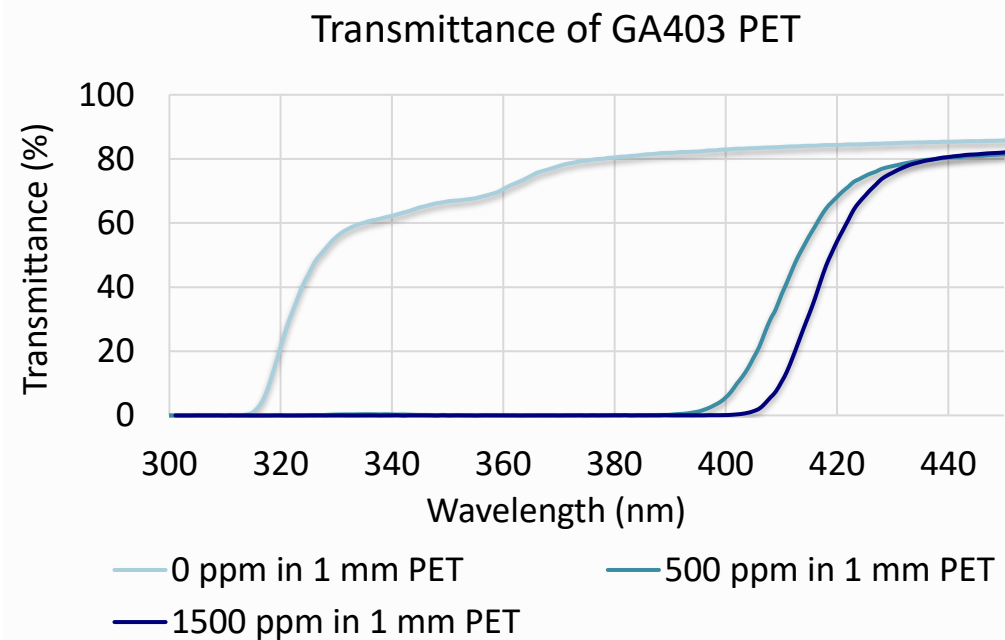
Chitec Technology
2019.11

chitec

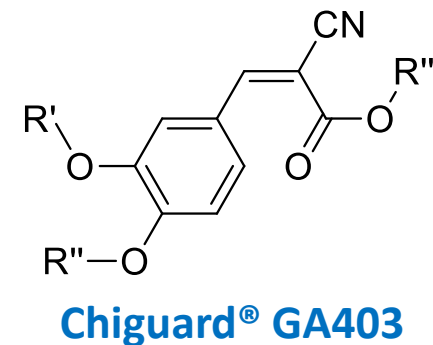
UV Blockers for PET

Structure	Chemistry Base	Commercial Products	Remark
	Cyanoacrylate	Chiguard® GA403 390B	- UV block up to 410nm - UV400 requirement - Lower photopermanence
	Phenyl Benzoxazin	Chiguard® 380W Cyasorb® UV-3638	- UV block up to 380 nm - Colorless - UV380 requirement - Lower photopermanence
	Hydroxyphenyl triazine	Chiguard® 410 Tinuvin® 479	- UV block up to 410 nm - High photopermanence - Very Expensive - Dark color, affecting product appearance.
	Zinc Oxide	-	- UV block up to 370 nm - Haze

UV Blocker – Chiguard® GA403



- Above 320nm, pure PET allows UV radiation to pass through.
- Chiguard® GA403 (GA403) provides UV protection up to wavelength 405nm, which extend shelf life for UV sensitive **food, beverage, personal care and home cleaning products** packaged in PET containers.



CAS NO.: proprietary

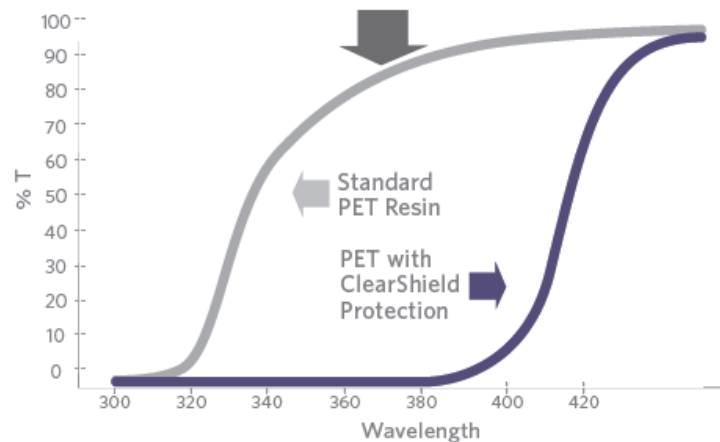


Milliken ClearShield™ 390B

Attributes

- Protection from damaging UV light
- Protecting more natural ingredients
- Extended shelf life of packaged contents
- Protecting brand image
- No extraction into formulation
- Resists plate out

The added protection of ClearShield
5% transmission at 390nm.



Case Studies

Brand Identity

Commercial Shampoo

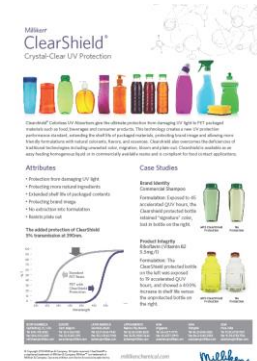
Formulation: Exposed to 45 accelerated QUV hours, the Clearshield protected bottle retained "signature" color, lost in bottle on the right.



Product Integrity

Riboflavin (Vitamin B2
5.5mg/l)

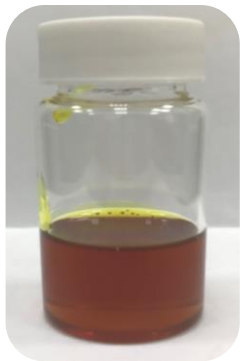
Formulation: The ClearShield protected bottle on the left was exposed to 19 accelerated QUV hours, and showed a 400% increase in shelf life versus the unprotected bottle on the right.



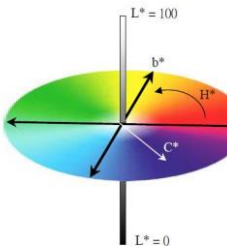
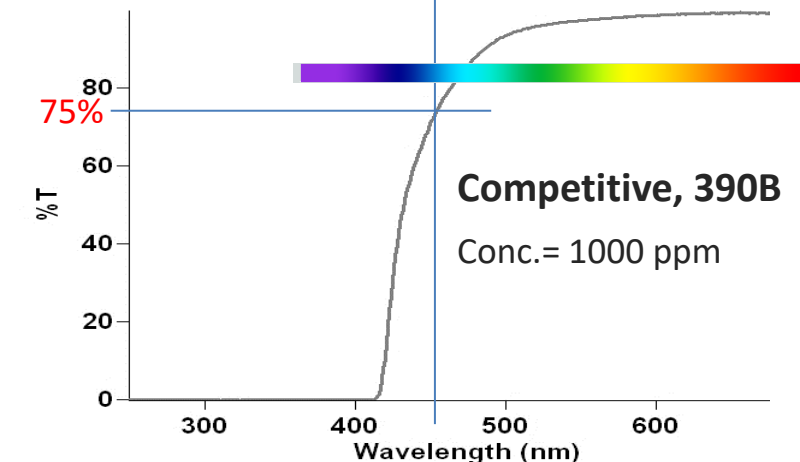
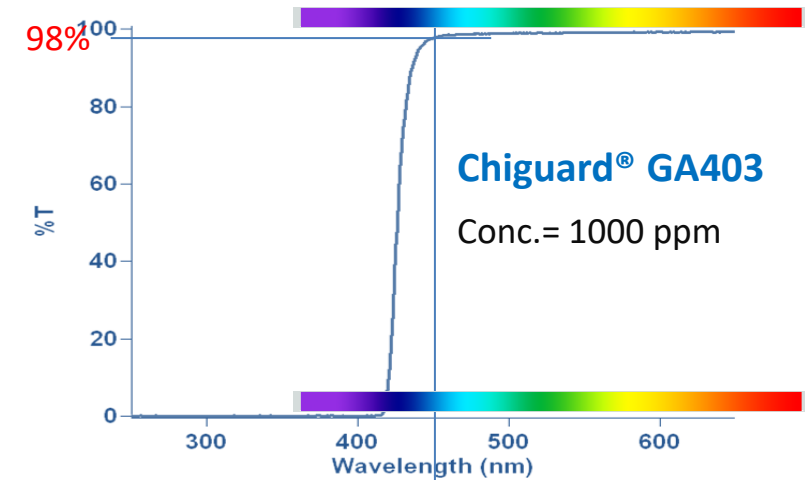
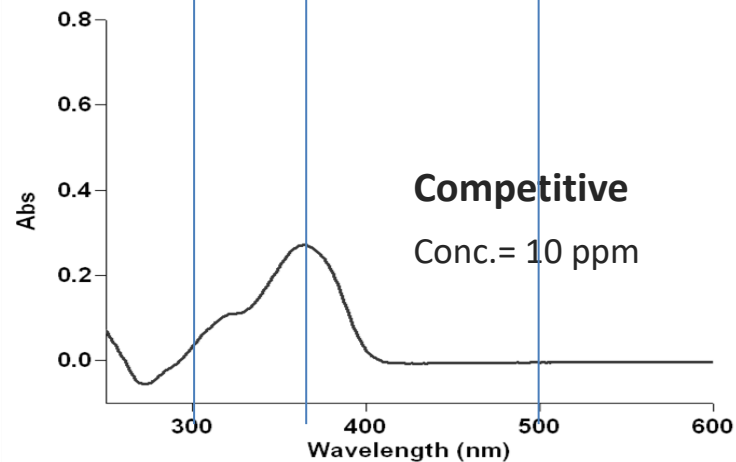
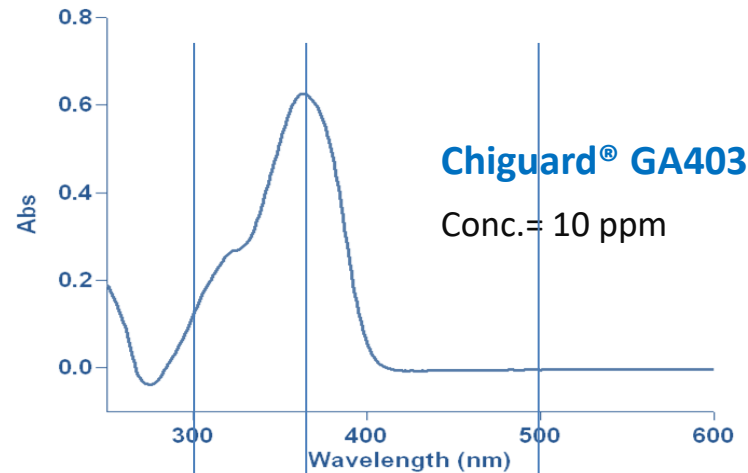
Appearance and UV spectrum – GA403 VS. Competitive



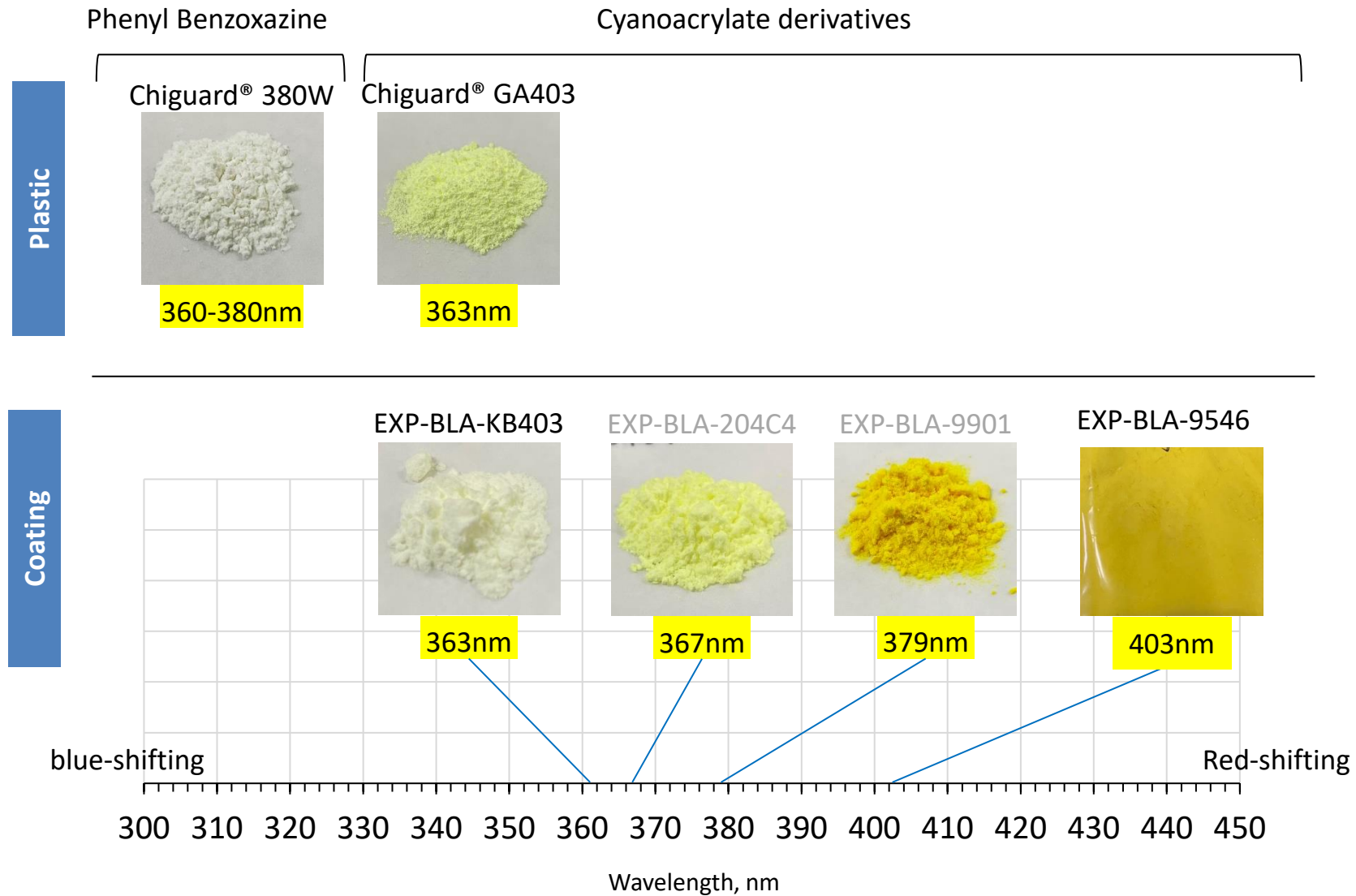
Chiguard® GA403



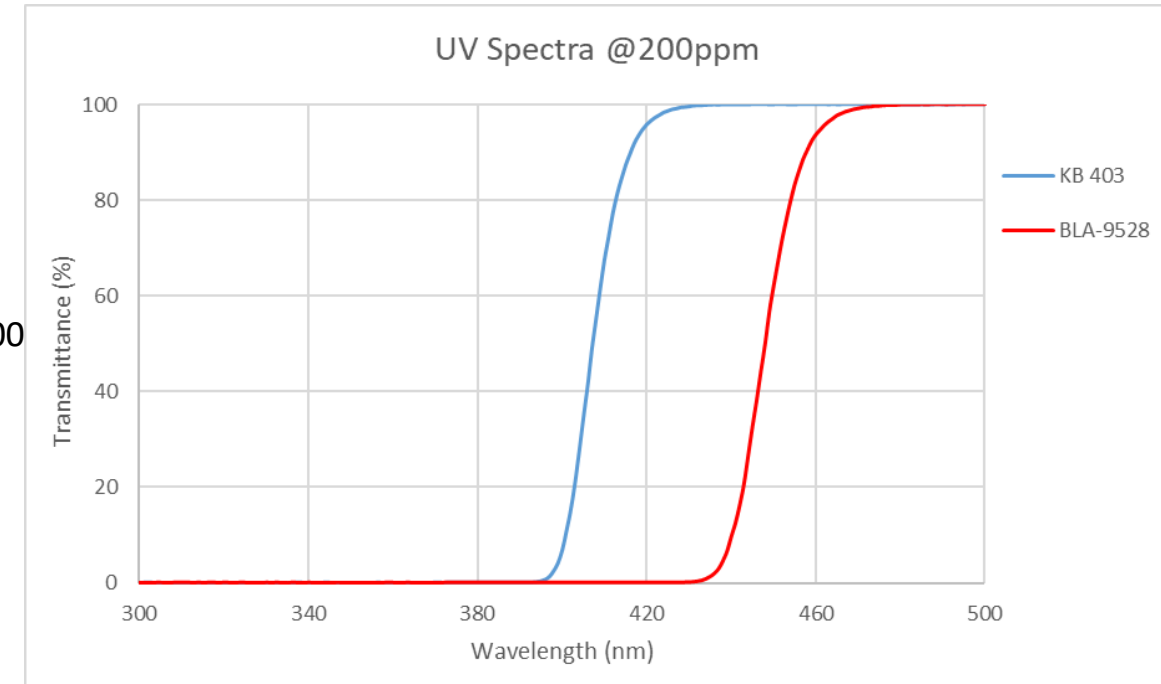
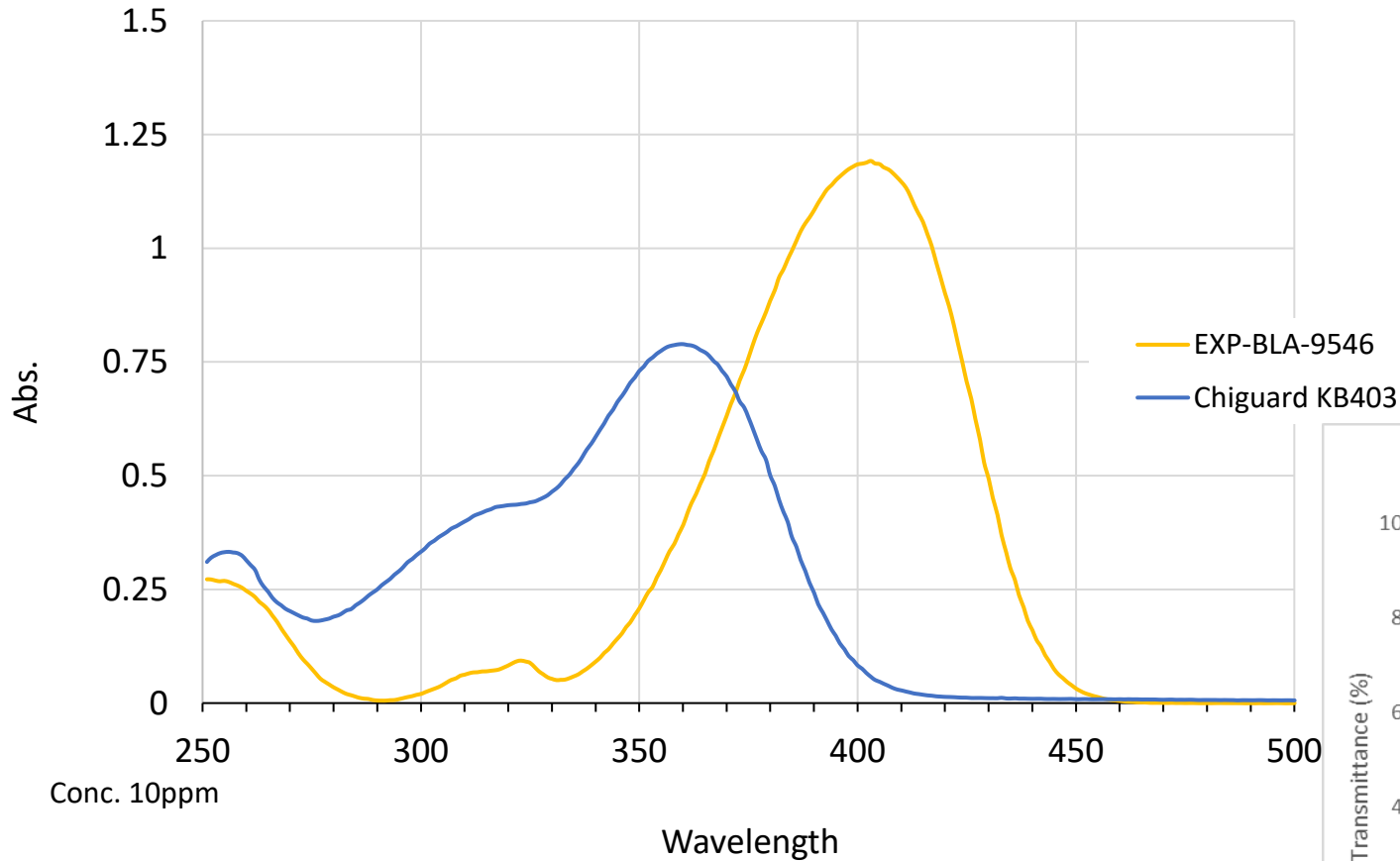
Competitive



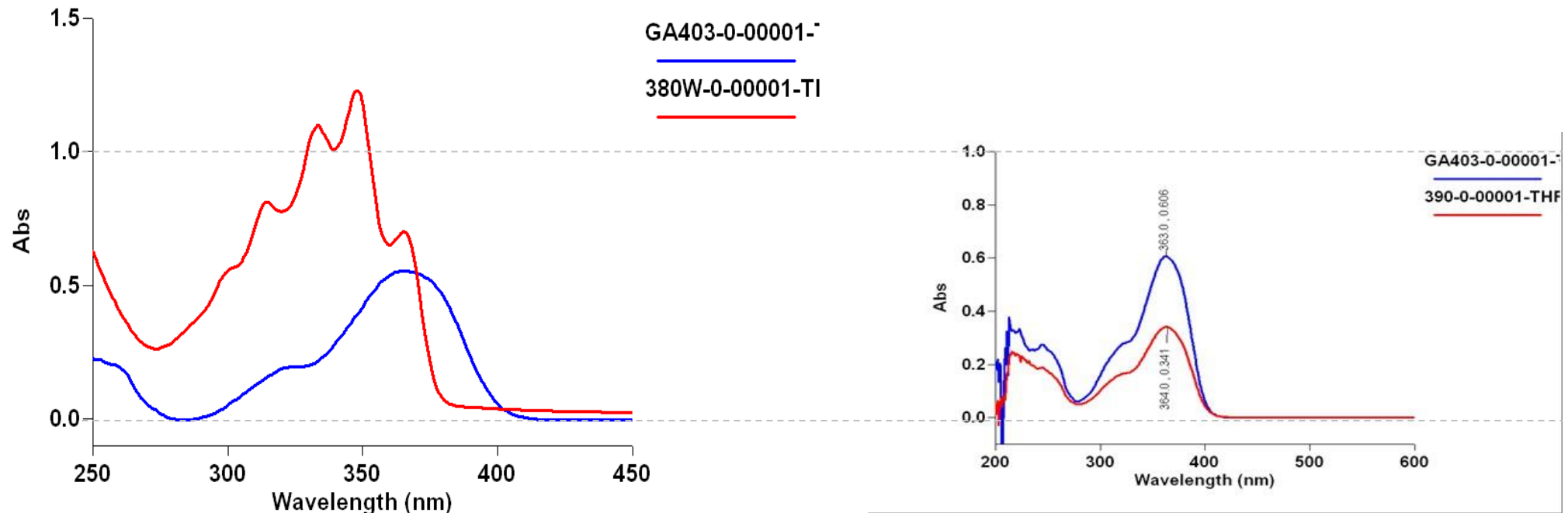
Reference Data – BLA Candidates



Absorption Spectra of Coating Grade UV Blockers

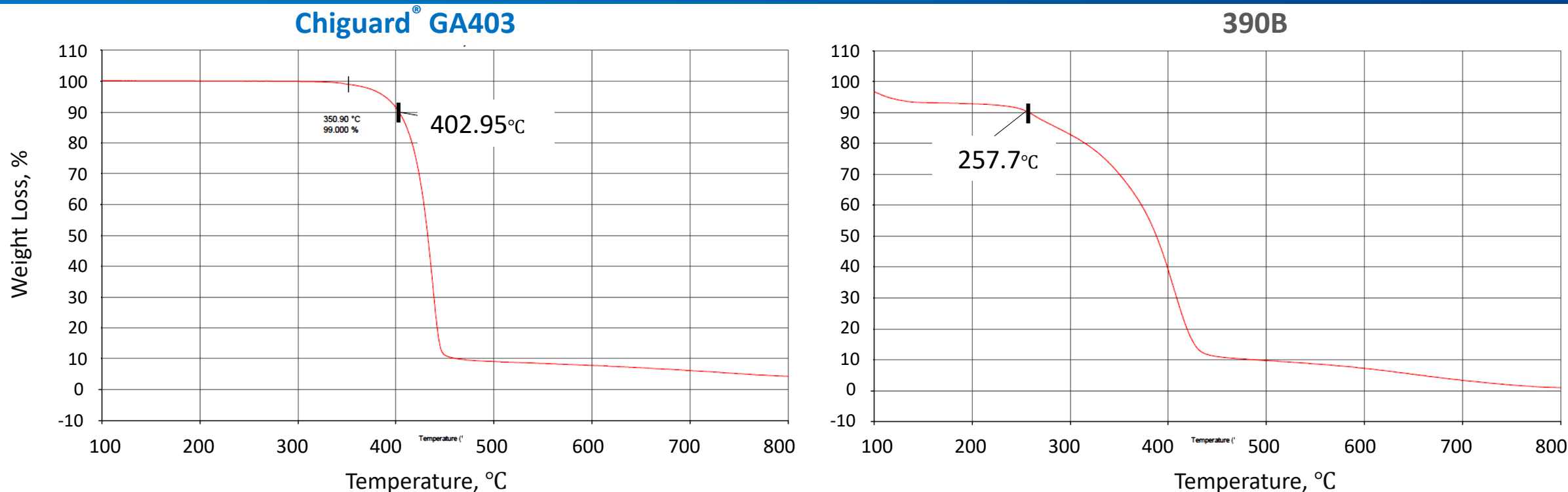


380W vs. GA403 vs. 390B



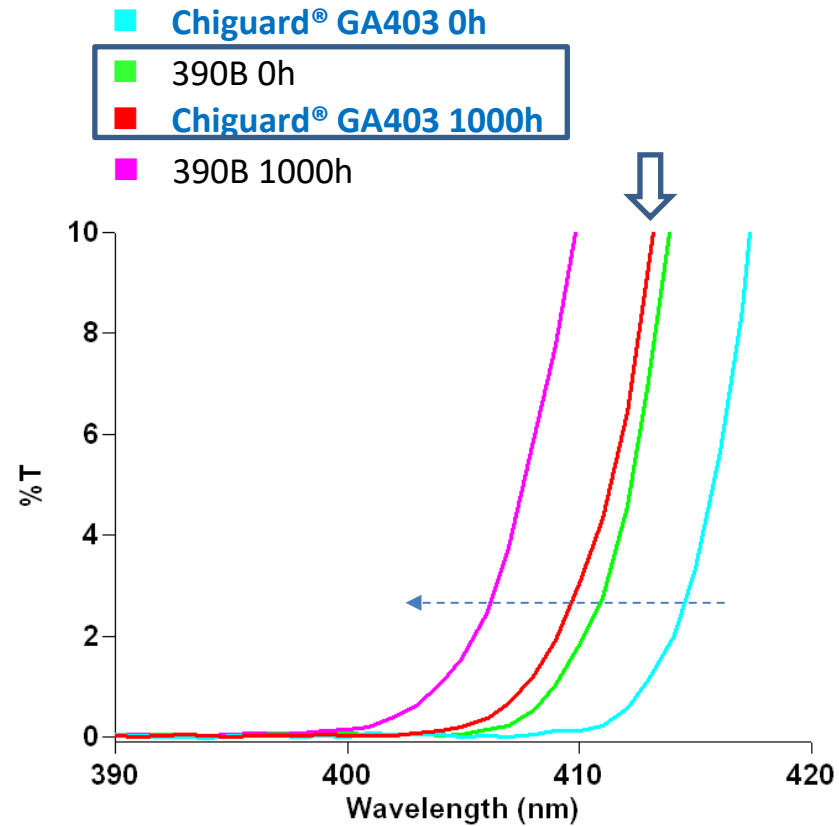
- Absorption Strength: 380W > GA403 > 390B

Heat Stability Comparison of GA403 & 390B

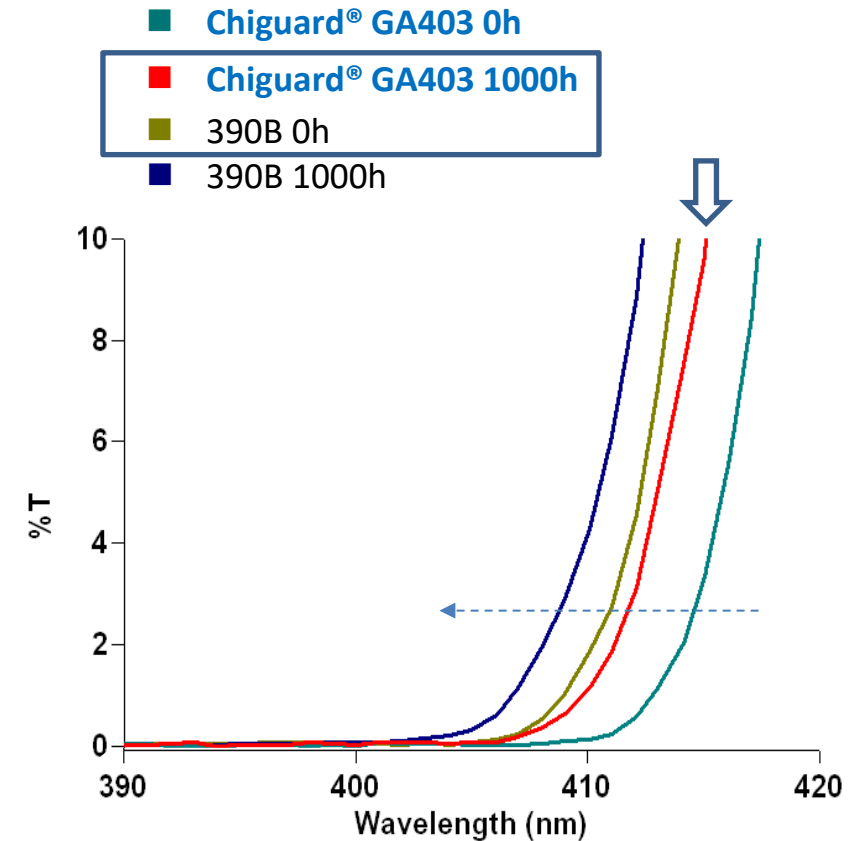


■ Chiguard® GA403 displays a high heat stability of TGA 10% weight loss at 402.95°C, compared to 390B's 257.7°C. This pharmaceutical sample was characterized by the STA 6000 and STA 8000. The Red DSC thermal curve and the Blue TGA weight loss curve are displayed above. This sample is a free base, small-molecule crystalline powder. The DSC curve indicates that there is a crystalline melt defined by the peak temperature at 228.37 °C. After the melt transition, the baseline returns to a slightly lower position than the pre-melt baseline. This change of 1.4 mW, 19.18 mW less 17.77 mW indicates that the liquid phase has a lower heat capacity (C_p) than the crystalline phase. The post-melt baseline changes slope as the sample begins decomposition. The DSC exothermic decomposition peak at 287.2 °C corresponds to the TGA extrapolated onset temperature of 287.2 °C as this sample decomposes.

Accelerated Weathering Test – QSUN & QUV



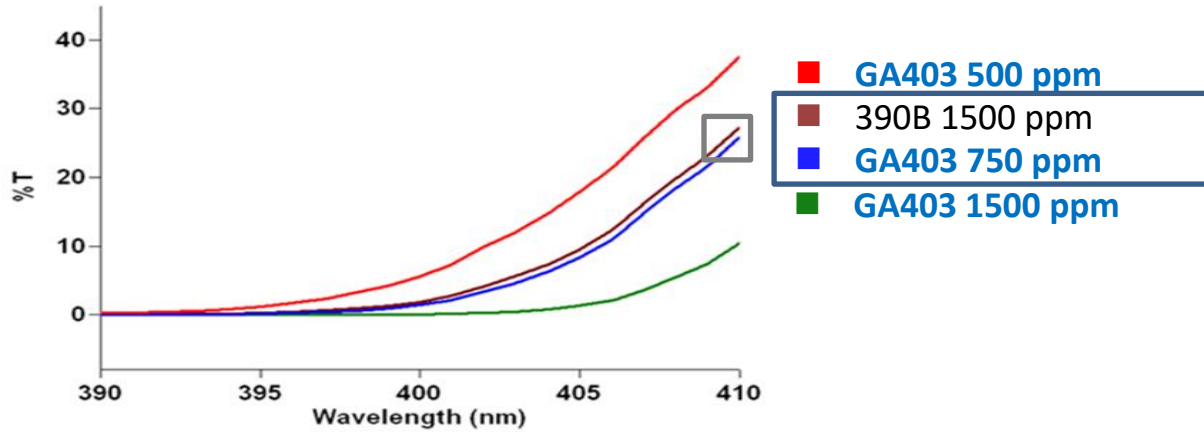
QSUN



QUV 340

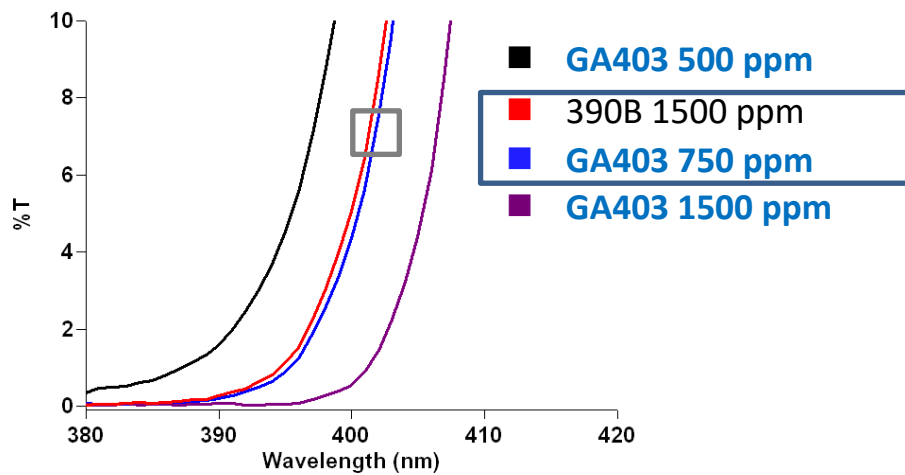
UV Block Ability VS. Dosage

0 h

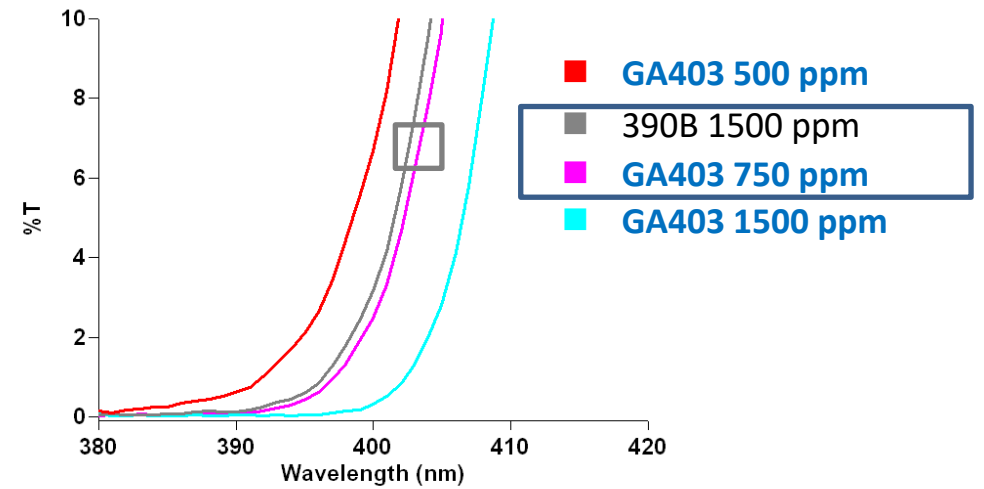


• PET film= 1mm

160 h



QSUN



QUV 340

Non-migration in PET

Migration Test Results

GA403 form Food Simulant	Blank	1400ppm GA403 in film in Simulant*
10% Ethanol	Not detectable**(ND)	ND**
3% Acetic Acid	ND**	ND**
Vegetable oil	ND**	ND**

* Test condition is set in food simulant under 60°C for 10 days, and the results are analyzed by HPLC-UV

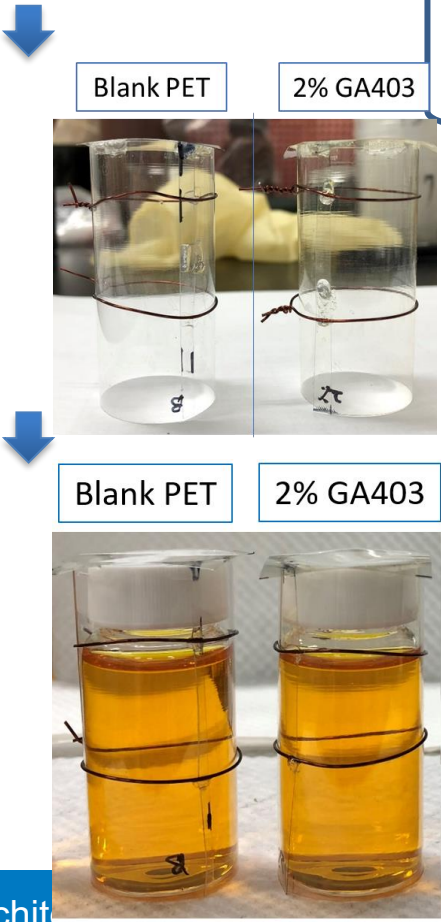
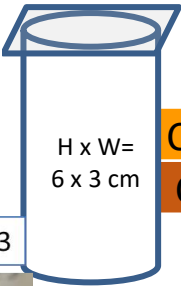
**Detection Limit : 50 ppb

- A pre-test before entering the FDA migration test.

Absorption= $e \times b \times c$
 $A1 = e \times 300\mu m \times 2\% = 600$ of $A =$ target
to protect the dyestuff
 $A2 = e \times 100\mu m \times 6\% = 600$

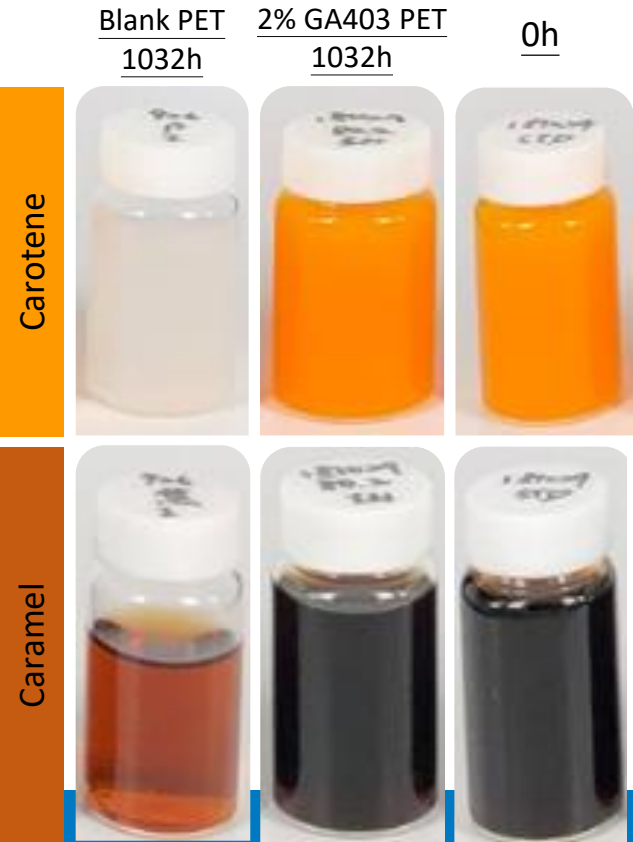
$A = e \times 80\mu m \times 5\% = 400$
 $A = e \times 80\mu m \times 2\% = 160 =$ critical value
1% max.
 $A = e \times 320\mu m \times 0.5\% = 160$
 $A = e \times 30\mu m \times 2\% = 60$

PET Bottle
Simulation



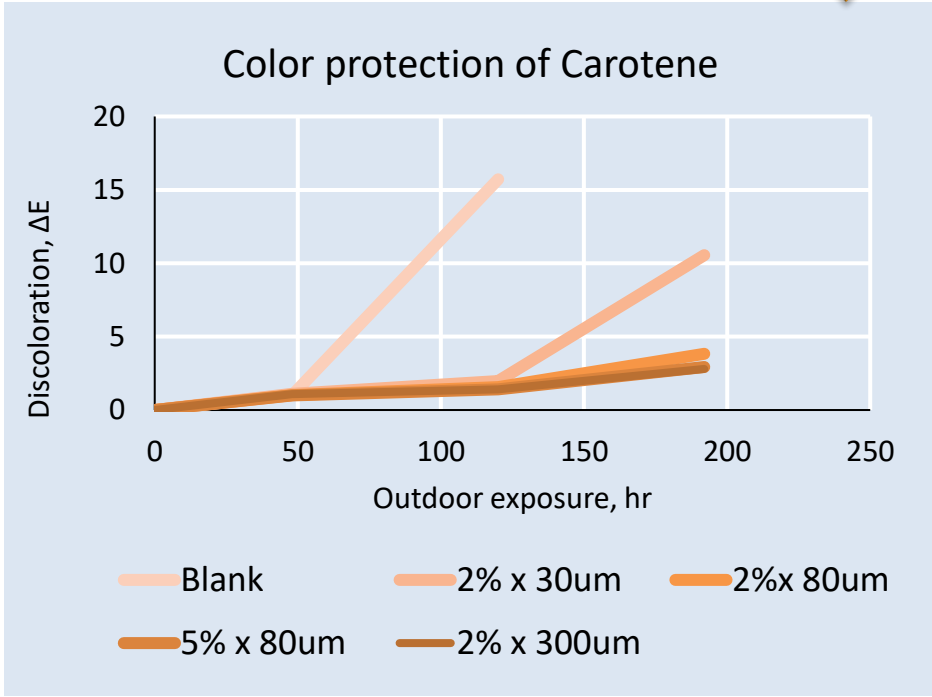
Indoor Exposure

	Blank 1032h, ΔE	2% GA403 x 80um 1032h, ΔE
Carotene	8	0.97
Caramel	0.94	0.23



Outdoor Exposure

	Blank 120h, ΔE	2% GA403 x 80um 192h, ΔE
Carotene	15.72	3.83
Caramel	4.49	0.79



UV-Cut is Different from UV400 Requirement

ANSI Z87.1-2015

The UV Scale uses a rather complicated mathematical formula, however, for simplicity, it's divided into two wavelength categories, far and near.

Far-ultraviolet is defined as; Transmittance of optical radiation with wavelengths from **200 to 315 nanometers** weighted by its ability to damage the cornea.

Near-ultraviolet is defined as; Transmittance of optical radiation with wavelengths from **315 to 380 nanometers**.

<https://blog.safetyglassesusa.com/what-does-ansi-z87-1-2010-certified-mean/>



LS102
Meter

Details

LS102 optical transmittance measurement instrument is Lin Techno high precision transmittance measurement instrument, LS102 prof organic materials, coatings, such as optical transmittance of transpa sandwich glass, hollow glass, film glass, PMMA material, PC materia

Parameters:

1. Size: 160mm*115mm*33mm(L*W*H)
2. Testing opening: Wide 43mm * Height 76 mm
3. Weight: 425g
4. Resolution: measure value <10% is 0.1%, other rang
5. Accuracy: ±2%(Colorless and transparent n
6. UV center wavelength: 365nm
7. Visible light wavelength: 380nm-760nm (Full Weighted Spectrum)
8. IR Center wavelength 1400nm
9. Power supply: 9V DC/Portable plug in lithium battery

http://www.lsmeter.com/product/LS102_EN.html

SGS Report of Sunglasses

b. Requirements For The Ultraviolet Spectral Range For Initial Tv (Luminous Transmittance)

Pass

Sample	Filter Category	Range	Requirement	Test Value	
				Left Ocular	Right Ocular
1	3	280 ~ 315 nm TSUVB	<1.0 %	0.00 Tv (0.01 %)	0.00 Tv (0.01 %)
		315 ~ 380 nm TSUVA	<0.5 Tv	0.00 Tv (0.01 %)	0.00 Tv (0.01 %)

9 Resistance to ignition

Pass

Finding

Sample 3 was assessed. Sample was not ignited or continued to glow after removal of the steel rod.

11 Protective requirements

11.1 Coverage area

Pass

Finding

Sample	Requirement	Test Value
3	Horizontal diameter $\geq$ 40 mm	> 40 mm
	Vertical diameter $\geq$ 28 mm	> 28 mm
	The centres of which are separated by 64 mm	Pass

Excluded

12 Information and labelling

2. UV 400 Transmittance (The transmittance between 280nm and 400nm)

Pass

Finding

Sample	Test Item	Requirement	Test Value	
			Left Ocular	Right Ocular
1	UV 400	In the case where it is claimed that a filter has less than x % UV transmittance, the solar UV transmittance of the filter shall	0.03 %	0.03 %

EN ISO 12312-1:2013

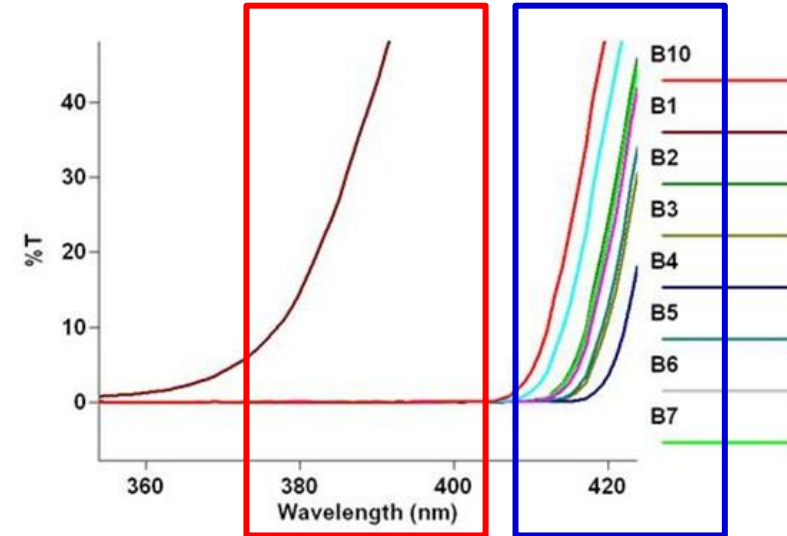
380W vs. GA403: UV380 or UV400?



380w, 0.4%,
1mm PET

	UV	VIS	IR
Blank	47	85	92
380W	0	79	90
380W-QSUN-192 hrs	0	82	90
380W-QUV-192 hrs	0	83	92
380W-QSUN-292 hrs	0	82	92
380W-QUV-292 hrs	0	84	92
380W-QSUN-400 hrs	0	81	90
380W-QUV-400 hrs	0	84	92
380W-QSUN-500 hrs	0	81	90
380W-QUV-500 hrs	0	82	91

380w, 1%,
1mm PET



GA403,
0.2 – 1%
1mm PET



- Chiguard® 380w -> A product for UV cut
- Chiguard® GA403 -> A product for UV400

“Define” the Wavelength (λ) of Critical Absorption

EN 1836: 2005	AS/NZS 1067: 2003	ANSI Z80.3: 2001	ISO DRAFT 12312.1
315 - 380 nm $T_{\text{SUVA}} \leq T_v$ for categories 0-2 $T_{\text{SUVA}} \leq 0.5T_v$ for categories 3 and 4	315 - 400 nm $T_{\text{SUVA}} \leq T_v$ for categories 0-2 $T_{\text{SUVA}} \leq 0.50T_v$ for categories 3 and 4 at all points in 28 mm diameter circle	315 - 380 nm $T_{\text{SUVA}} \leq T_v$	315 - 380 nm $T_{\text{SUVA}} \leq T_v$ for categories 0 and 1 $T_{\text{SUVA}} \leq 0.5T_v$ for categories 2-3 <u>$T_{\text{SUVA}} \leq 1\%$ absolut</u> or $\leq 0.25T_v$ for categorie 4
T_{SUVA} is the solar UVA transmittance			

Tab.2: UV-A Protection Requirements

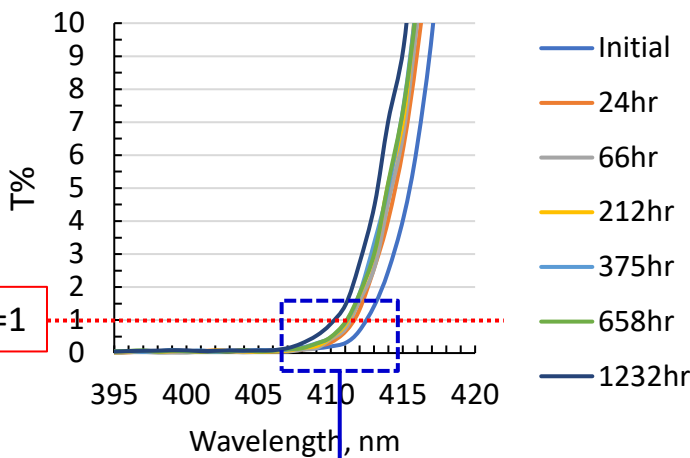
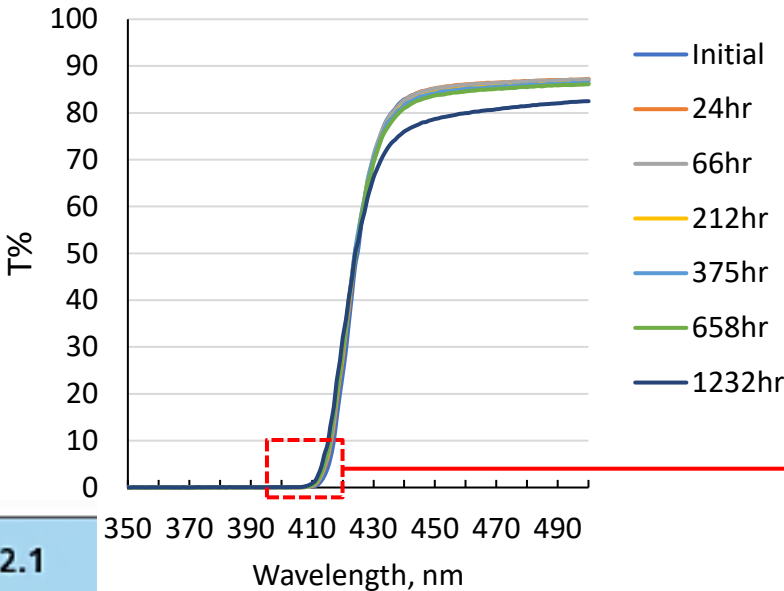
Definition:

Define Critical Absorption = $T\% \leq 1\%$

Define λ of Critical Absorption = λ of $T\% \leq 1\%$

Collecting Critical Absorption data of PET film

1.0% GA403 @ 1.1mm PET film



ISO DRAFT 12312.1

315 - 380 nm

$T_{SUVA} \leq T_V$
for categories 0 and 1

$T_{SUVA} \leq 0.5T_V$
for categories 2-3

$T_{SUVA} \leq 1\%$ absolut
or $\leq 0.25T_V$ for categorie 4

Definition:

λ of critical absorption = λ of $T\% < 1\%$

UV transmittance after QUV Aging

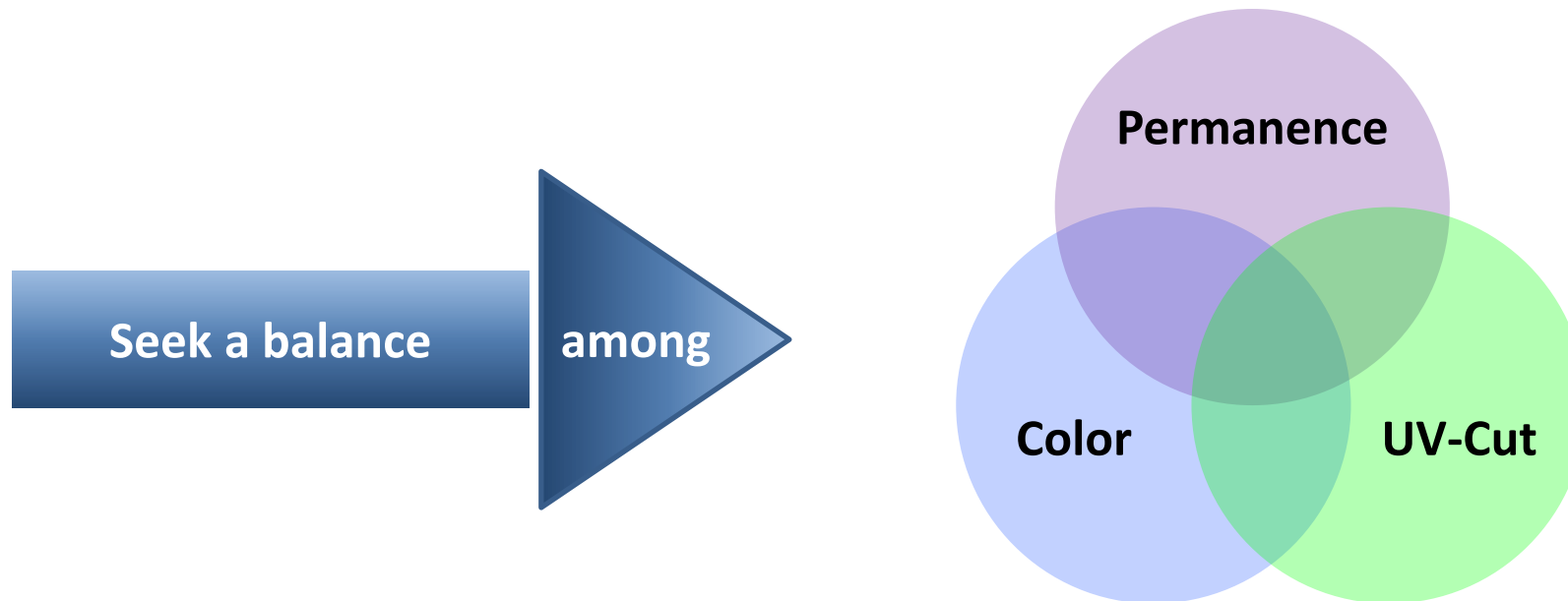
$T\% \leq 1\%$

λ	Initial	24hr	66hr	212hr	375hr	658hr	1232hr
411.96	0.67	1.29	1.57	1.73	1.76	1.77	2.68
411.04	0.31	0.66	0.74	0.87	0.93	0.96	1.48
409.96	0.20	0.31	0.41	0.44	0.46	0.47	0.87

The Essential Index to Evaluate UV Blocker Performances

Four indexes evaluate the UV blocker performance:

1. Initial color
2. Discoloration after UV aging
3. Wavelength of Critical Absorption
4. Decay of UV-cut (photopermanence)



1% UV Blocker @ 1.1mm PET

EXP 1 Performances on “Same Coat”

380W= 50 USD/kg, GA403= 80USD/kg

EXP目的	cost= \$50, STD	cost= \$50	cost= \$50
NO.	1	2	3
380W, wt%	1	0.5	0
GA403, wt%	0	0.3	0.625
0hr YI	1.2	11	12.6
1300 hr DYI	6.9	1.0	3.4
wavelength of 1% T% T0/ T1232	385/387	412/410	415/413

EXP 2 UVA 1%, Performance Check: Combination of GA403 and 380W

EXP目的	STD	3/1	1/1
NO.	4	5	6
GA403, wt%	1	0.75	0.5
380W, wt%	0	0.25	0.5
0hr YI	13.7	12.6	10.8
1300 hr DYI	4.9	2.1	1.6
wavelength of 1% T% T0/ T1232	417/416	415/412	412/410

EXP 2.1

UVA 1%, Performance Check: Combining BTZ UVA

EXP目的	STD	403/380w/234= 1/0.5/0.5	403/ 380W= 1/3
NO.	7	8	9
GA403, wt%	0.5	0.5	0.25
380W, wt%		0.25	0.75
234, wt%	0.5	0.25	
0hr YI	11.0	11	8.6
1300 hr DYI	3.8	2.4	1.1
wavelength of 1% T% T0/ T1232	412/411	413/411	409/407



1.1mm



0.1mm

@ 0.1mm PET

EXP 1 Performances on "Same Coat"

380W= 50 USD/kg, GA403= 80USD/kg

EXP目的	cost= \$50, STD	cost= \$50	cost= \$50
NO.	1	2	3
380W, wt%	1	0.5	0
GA403, wt%	0	0.3	0.625
0hr YI			
1300 hr DYI			
wavelength of 1% T% T0	TBD Recheck	393	391

EXP 2 UVA 1%, Performance Check: Combination of GA403 and 380W

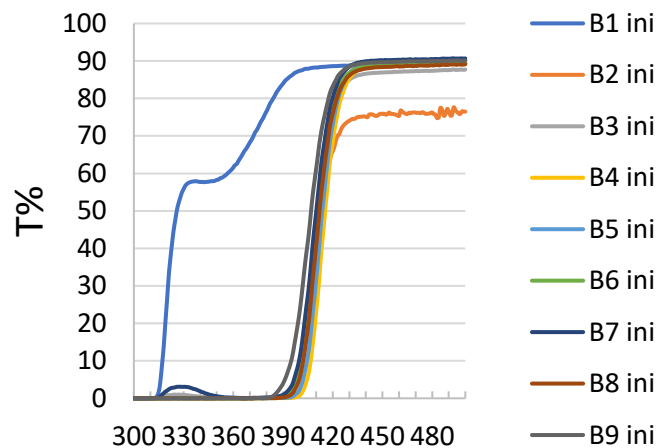
EXP目的	STD	3/1	1/1	1/3
NO.	4	5	6	9
GA403, wt%	1	0.75	0.5	0.25
380W, wt%	0	0.25	0.5	0.75
0hr YI				
1300 hr DYI				
wavelength of 1% T%, T0	400	396	393	385

EXP 2.1

UVA 1%, Performance Check: Combining BTZ UVA

EXP目的	403/380w/234 = 1/0.5/0.5
NO.	8
GA403, wt%	0.5
380W, wt%	0.25
234, wt%	0.25
0hr YI	
1300 hr DYI	
wavelength of 1% T%, T0	393

Ini. T% @ 100um PET



Wavelength

@ 0.1mm PET,

- GA403 至少需加0.75% 才能勉強達到 UV400
- 0.25% GA403即可達到 UV380 cut (0.4% 380w @ 2mm PET)

Follow-Up EXP: 1.5% UV Blocker @ 0.1mm PET

Topic 1 – How can GA403 replace 380W

380W= 50 USD/kg, GA403= 80USD/kg
@ 0.1mm PET

Purpose	cost= \$50, STD	cost= \$20	cost= \$40
NO.	1	2	3
GA403, wt%	0	0.25	0.25
380W, wt%	1	0	0.4
0hr YI			
1300 hr DYI			
wavelength of 1% T% 0hr/ 1232			

Topic 2 – GA403+380W for UV400

@ 0.1mm PET

Purpose	STD	1/1	1/2
NO.	4	5	6
GA403, wt%	1.5	0.8	0.5
380W, wt%	0	0.7	1.0
0hr YI			
1300 hr DYI			
wavelength of 1% T% T0/ T1232			



Topic 3 – GA403+380W+BTZ for UV400

@ 0.1mm PET

Purpose	403/380w/234= 1/0.5/0.5
NO.	7
GA403, wt%	0.8
380W, wt%	0.37
234, wt%	0.37
0hr YI	
1300 hr DYI	
wavelength of 1% T% T0/ T1232	

	NO.	1	2	3	4	5	6	7
PET		100	100	100	100	100	100	100
AO	Deox3114	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	RV608	0.1	0.1	0.1	0.1	0.1	0.1	0.1
UVA	CG GA403		0.25	0.25	1.5	0.8	0.5	0.8
	CG 380W	1		0.4		0.7	1	0.37
	CG 234							0.37

- 100um 的數據在光老化之後會無法達成UV400 cut
- Topic 2&3 用雙層膜達到200um

The Performance of GA403 and 380W combination in Thick PET Film

1.1mm PET @ QUV340 test UVA=1%, GA403 and 380W combination					
Chiguard GA403, wt%	0	1	0.75	0.5	0.25
Chiguard 380W, wt%	1	0	0.25	0.5	0.75
0hr YI	1.2	13.7	12.6	10.8	8.6
1300 hrs ΔYI	6.9	4.9 (13.7+4.9= 18.6)	2.1	1.6	1.1
Wavelength @T% <1% 0 hr	385	417	415	412	409
Wavelength @T% <1% 1232 hrs	385	416	412	410	407
Decay of UV-cut	--	-1nm	-3nm	-2nm	-2nm

- The wavelength of Critical Absorption of 380W is hardly to reach 390nm even under high dosage. The combination with GA403 could help to extend the UV coverage up to 410nm.
- For the 1.1mm PET film application, only 0.25% of GA403 could easily block UV up to 400 nm.

The Performance of GA403, 380W & BTZ Combination in Thick PET film

1.1mm PET @ QUV340 test UVA=1%, GA403, 380W and 234 combination			
Chiguard GA403, wt%	0.5	0.5	0.5
Chiguard 380W, wt%	0.5		0.25
Chiguard 234, wt%		0.5	0.25
0hr YI	10.8	11	11
1300 hrs ΔYI	1.6	3.8	2.4
Wavelength @T% <1% 0 hr	412	412	413
Wavelength @T% <1% 1232 hrs	410	411	411
Decay of UV-cut	-2nm	-1nm	-2nm

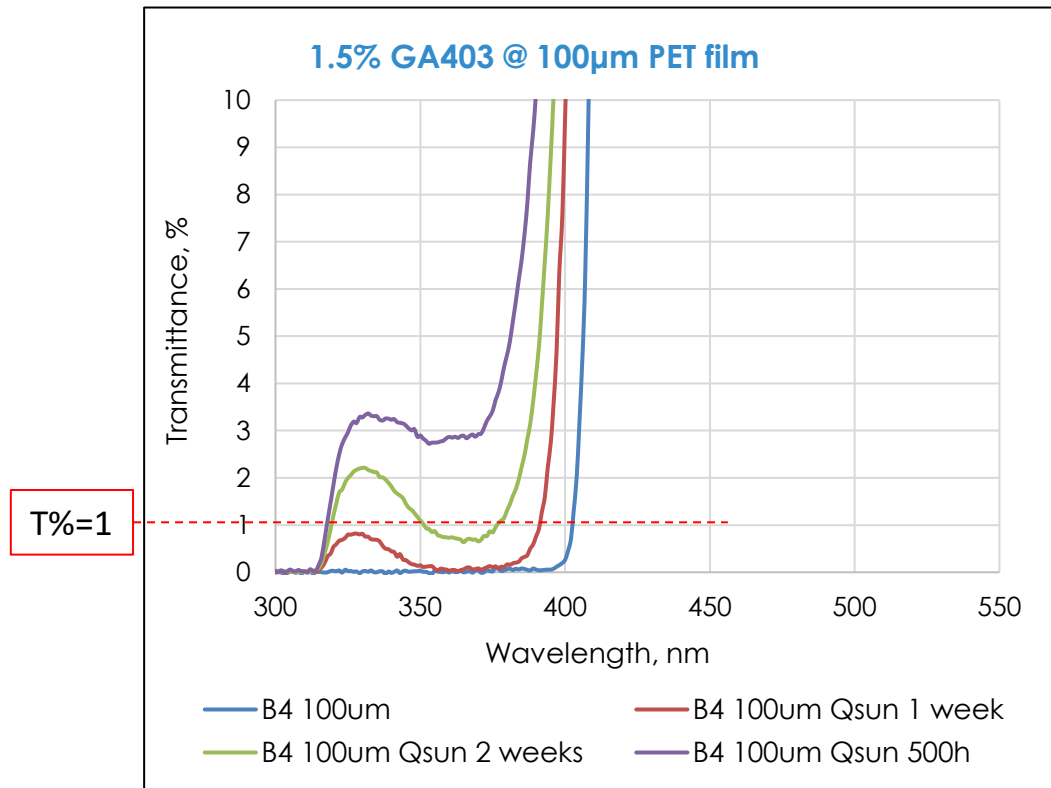
- The combination of BTZ UVA (Chiguard 234) shows similar performance compare to 380W which could be a potential combination for end applications. The overall performance could keep on the same level when 100% or 50% of 380W were replaced by BTZ UVA (CG 234).

The Complementarity of GA403 and 380W in PET Film Application -1

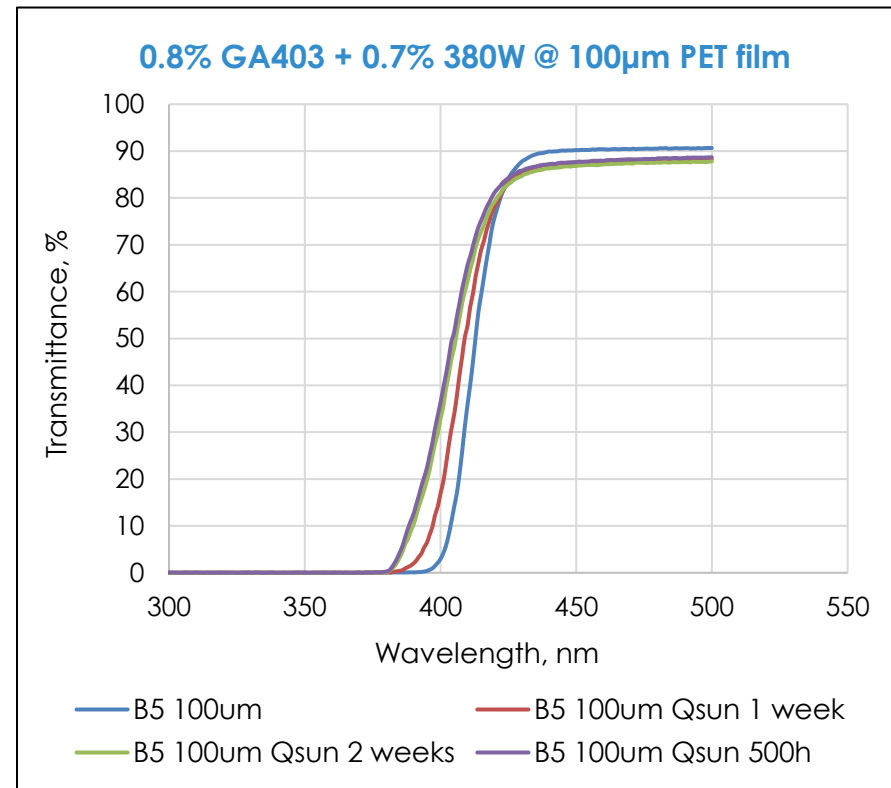
100µm PET, Xenon test UVA=1-1.5%, GA403, 380W and 234 combination					
Chiguard GA403, wt%		1.5	0.8	0.5	0.8
Chiguard 380W, wt%	1.0		0.7	1.0	0.35
Chiguard 234, wt%					0.35
0hr YI	0.7	5.1	3.7	2.5	3.5
336 hrs ΔYI	0.1	0.4	-0.8	-0.3	-0.5
Wavelength @T% <1% 0 hr	372	402	397	391	396
Wavelength @T% <1% 336 hrs	372	319*	382	382	381
Wavelength @T% <1% 500 hrs	372	317*	381	382	381
Decay of UV-cut	--	-85nm	-16nm	-9nm	-15nm

- For the 100µm PET film application, the high dosage of **380W** at 1% can only block UV up to 372nm. However, **380W** still plays a significant role by providing efficient UV coverage under 370nm, lower color, and cost reduction for the system
- **GA403** a essential material to bring a UVA system approach or cover over UV400 in ease.
- **GA403**, 380W and 234 combination shows better performance. However, it could not reach UV400 cut, and it shows significant decay of UV-cut after 500 hrs Qsun test

The Complementarity of GA403 and 380W in PET Film Application -2



*B4= 1.5% GA403



*B5= 0.8% GA403 + 0.7% 380W

- GA403 shows higher UV transmittance at around 320 nm in 100μm PET film application even at the high dosage of 1.5%, but it could be improved significantly through the combination with 380W.

The Complementarity of GA403 and 380W in PET Film Application -3

200µm PET, Xenon test UVA=1-1.5%, GA403 in combination with 380W and 234					
Chiguard GA403, wt%	1.5	0.8	0.5	0.8	0.8
Chiguard 380W, wt%	1.0	0.7	1.0	0.35	0.35
Chiguard 234, wt%					0.35
0hr YI	1.1	7.7	6.1	4.8	5.7
336 hrs ΔYI	0.4	0.1	-1.4	-1.0	-1.0
Wavelength @T% <1% 0 hr	383	407	404	399	403
Wavelength @T% <1% 336 hrs	383	398	393	390	393
Wavelength @T% <1% 500 hrs	382	395	390	387	391
Decay of UV-cut	-1nm	-12nm	-14nm	-12nm	-12nm

- In 200µm PET film application, 0.8% of GA403 in combination with 380W or 380W+234 is able to block the UV transmittance up to 400nm.
- The functional blending of GA403/ 380W/ 234 shows a very good balance among color, UV-cut and permanence, compared to all other combinations under the same film thickness.

The Synergist of GA403 and 380W in PET film application -4

300μm PET Xenon test

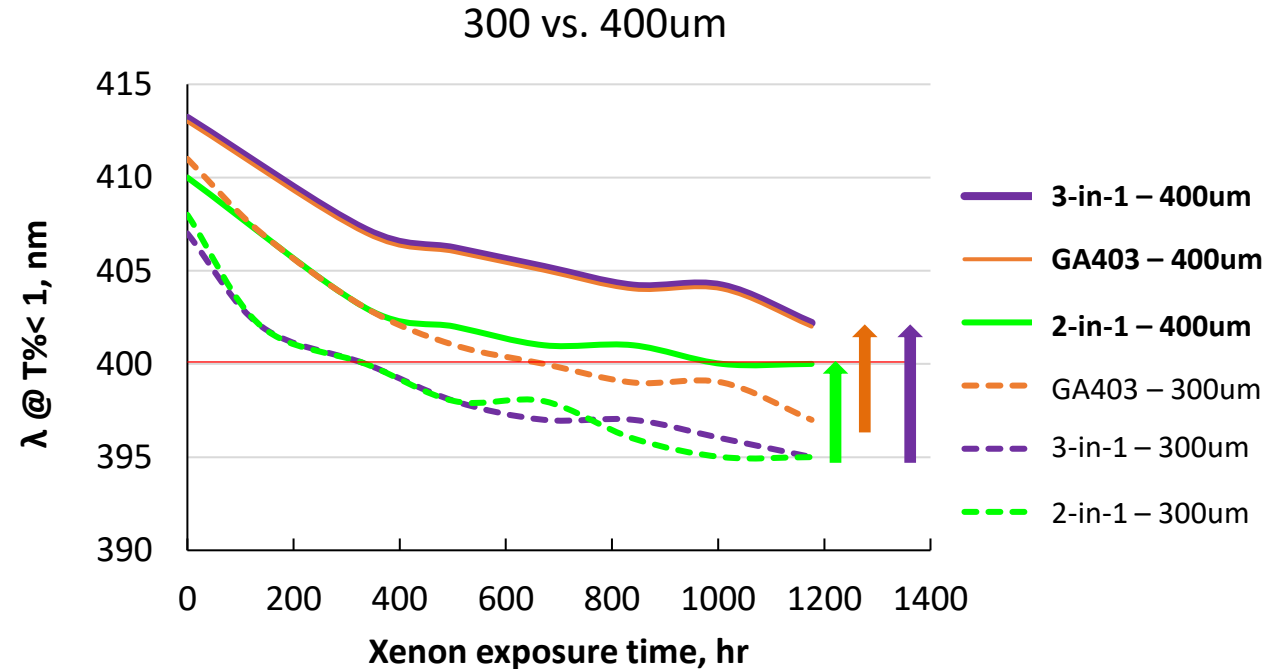
UVA=1.5%, GA403 in combination with 380W and 234

Code	GA403	2-in-1	3-in-1
Chiguard GA403, wt%	1.5	0.8	0.8
Chiguard 380W, wt%		0.7	0.35
Chiguard 234, wt%			0.35
0hr YI	10.4	8.2	7.8
1176 hrs ΔYI	-1.2	-2.2	-1.5
Wavelength @T% <1% 0 hr	411	408	407
Wavelength @T% <1% 1176 hrs	397	395	395
Decay of UV-cut	-14nm	-13nm	-12nm

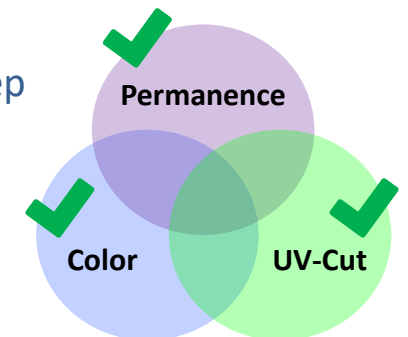
400μm PET Xenon test

UVA=1.5%, GA403 in combination with 380W and 234

Code	GA403	2-in-1	3-in-1
0hr YI	12	9.8	9.3
1176 hrs ΔYI	-1.1	-2.1	-1.7
Wavelength @T% <1% 0 hr	413	410	413
Wavelength @T% <1% 1176 hrs	402	400	402
Decay of UV-cut	-11nm	-10nm	-11nm



- Setting 7 weeks (1176hr) Xenon aging as a target, the UV blocker system is able to keep UV400 when the thickness increase to 400um.



GA403 Applied in Thick substrates

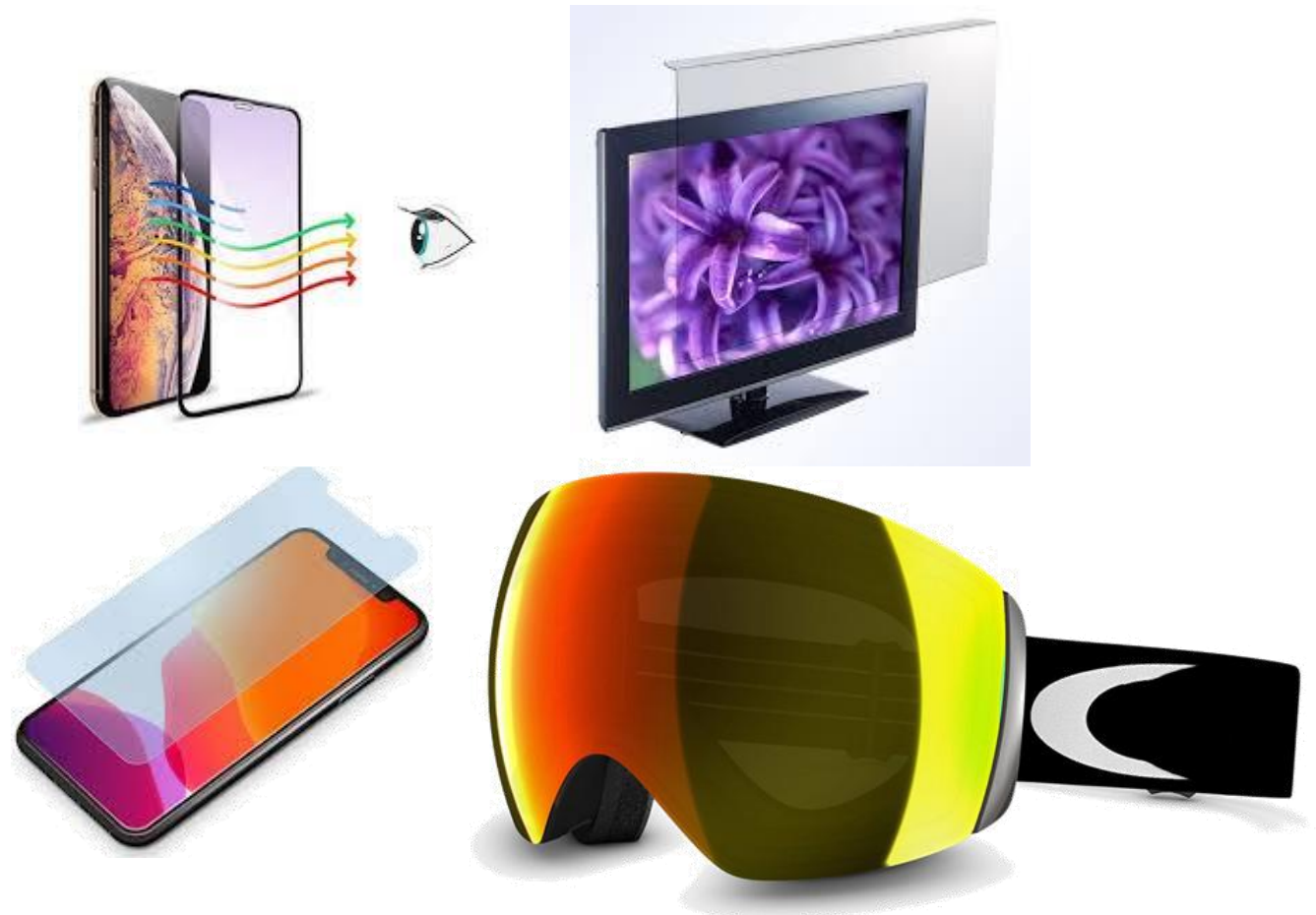
0.1% GA403 @ 2mm PMMA

Chiguard GA403, wt%	0.1
Wavelength @T% <1% 0 hr	406
Wavelength @T% <1% 3384 hrs (Outdoor)	404
Decay of UV-cut	-2nm

Processing Temp.= 240°C

0.2% GA403 @ 3mm PC

Chiguard GA403, wt%	0.2
Wavelength @T% <1% 0 hr	409
Wavelength @T% <1% 3384 hrs (Outdoor)	409
Wavelength @T% <1% 1876 hrs (Xenon)	408
Decay of UV-cut	-1nm



➤ In thick substrate, GA403 performs excellent photopermanence.

Demonstration of UV Block

0.2% GA403 @ 3mm PC

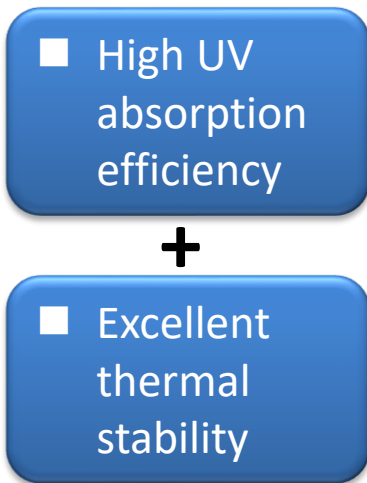


1% GA403 @ 1.1mm PET



*395nm LED UV light

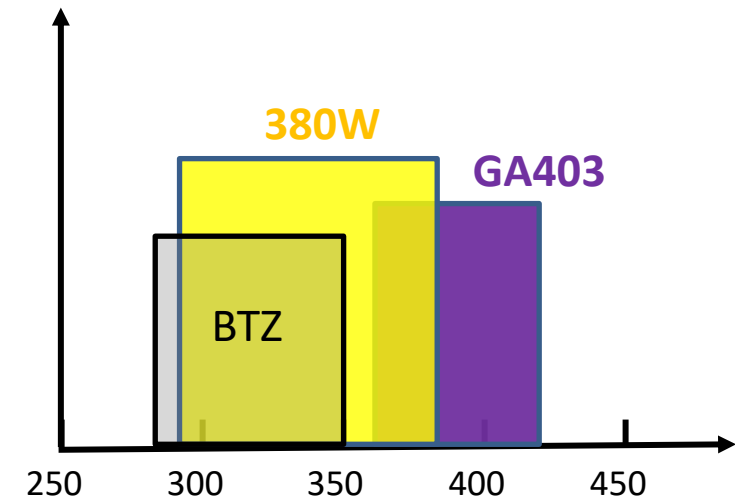
Conclusion



- ✓ Only require a half dosage of competitor's to achieve 400nm cut
- ✓ Low color contribution -> wide range of applications



- Chiguard® GA403 is **The Last Mile** when we want to create a UV400 filter. it helps the UVA system approach or cover over UV400 in ease.
- When we aim to formulating a efficient UV block system, Chiguard® 380W and low color BTZ UVAs plays a significant role by providing UV coverage under 370nm, lower color, and cost reduction for the system.
- In applications of thick substrates, GA403 shows excellent UV coverage, photopermanence and cost-efficient to formulations.



Advantages of Chiguard® GA403

■ High UV
absorption
efficiency

+

■ Excellent
thermal
stability



- ✓ Only require a half dosage of 390B's to achieve 400nm cut
- ✓ Low color contribution -> wide range of applications

■ Derived from
natural resource

+

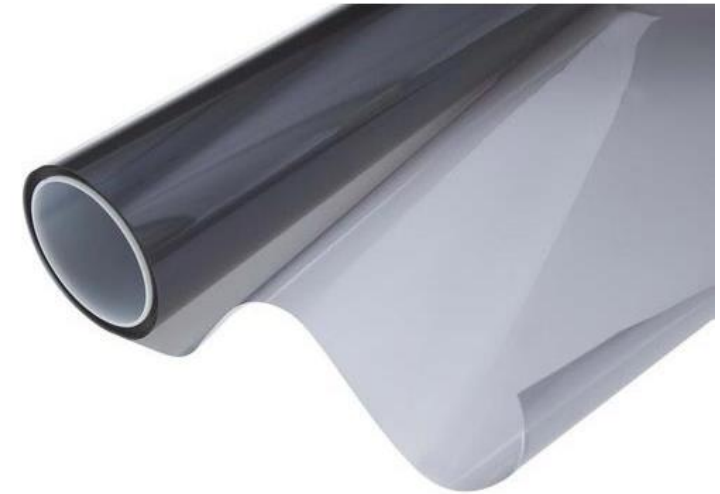
■ High compatibility
with most plastics



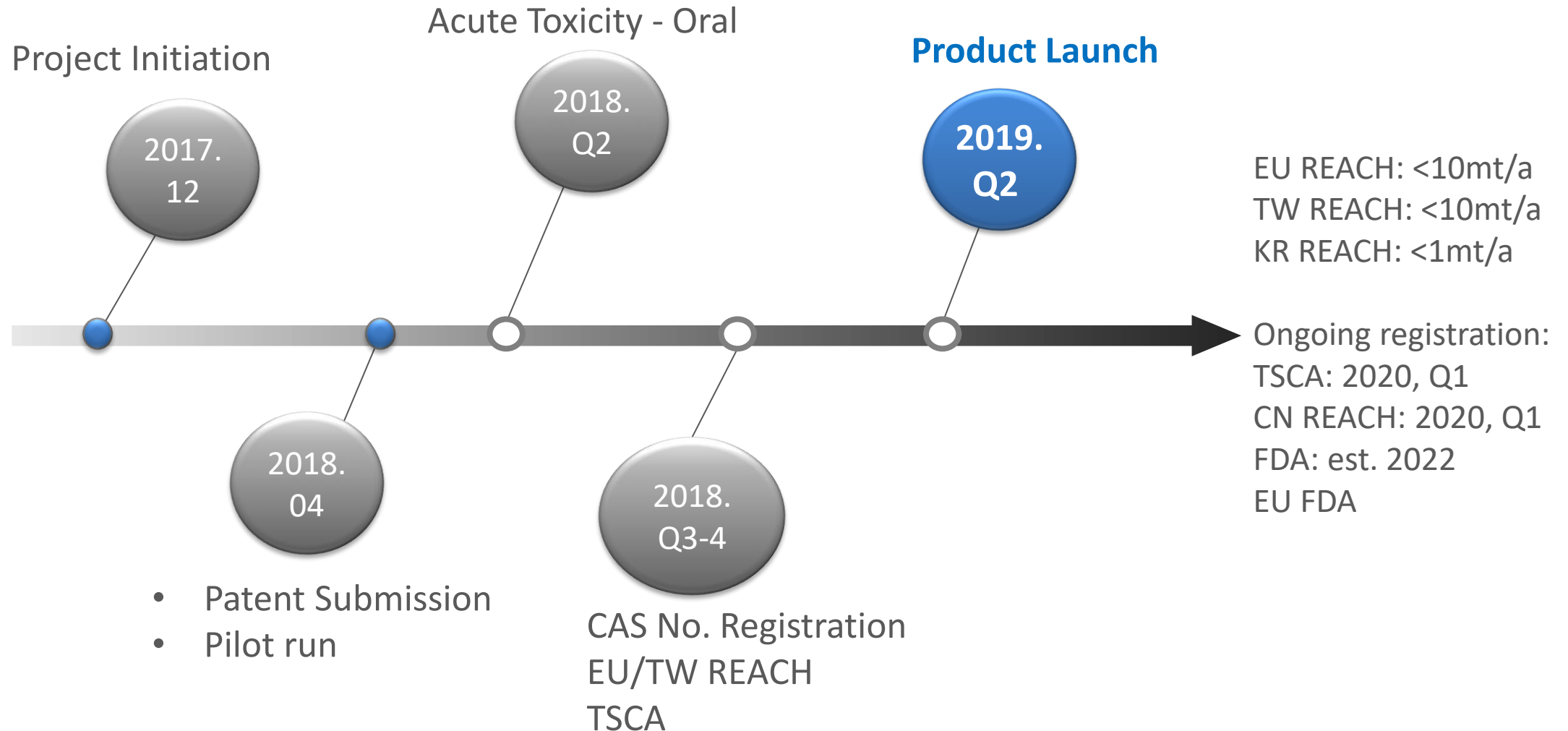
- ✓ Very low toxicity
- ✓ Non-migration in PET
- ✓ Food contact & FDA grade applications (ongoing)

Target Applications

1. PET or PC UV/ blue-light block optical film.
2. PET containers for protection of UV sensitive ingredients.



Schedule of Chiguard® GA403



Global Registration Status

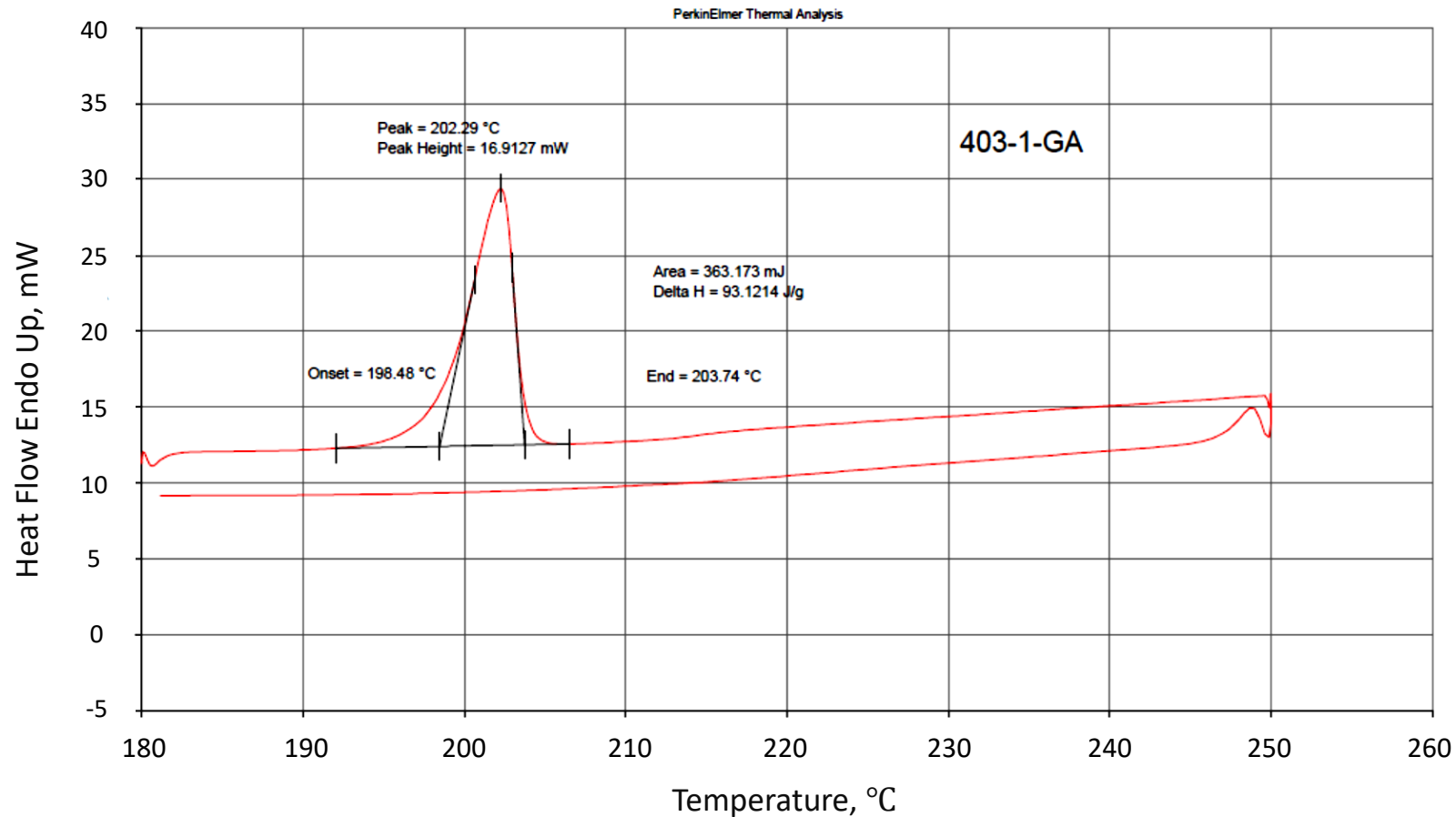
- **EU REACH**
1-10 tonnage registration
- **TSCA**
Complete in October 2020
- **CN REACH**
1-10 tonnage registration
- **TW REACH**
1-10 tonnage registration
<100MT/a is expected to complete in Q1, 2024
- **FDA**
Expected to complete in Q2, 2023
- **EFSA**
Expected to complete in Q2, 2024
- **Japan**
SVE <1MT/a
- **KR REACH**
<10MT/a is expected to complete in Q4, 2023
- **Available**
100MT/a

We pursue difference, not number.



Appendix

Chiguard® GA403 - DSC



- The crystalline melt point of Chiguard® GA403 is 202.3 °C, suitable for PET process.

Light Transmittance of GA403 PET



Material : PET
UVA : Chiguard® GA403
Dosage : **4,000 ppm**



Material : PET
UVA : 390B
Dosage : **4,000 ppm**



	UV	VIS	IR
Blank	47	85	92
Chiguard® GA403	0	79	91
Chiguard® GA403-QSUN-115 hrs	0	79	90
Chiguard® GA403-QUV-115 hrs	0	79	89
Chiguard® GA403-QSUN-192 hrs	0	80	89
Chiguard® GA403-QUV-192 hrs	0	80	90
Competitive	0	80	90
Competitive-QSUN-115 hrs	0	80	90
Competitive-QUV-115 hrs	0	80	90
Competitive-QSUN-192 hrs	0	81	91
Competitive-QUV-192 hrs	0	80	90



Input Method

- Using solvent borne UVA's is not always easy in WB formulations. You cannot normally formulate with solid UVA's in WB due to the solubility constraints. A UVA like Chiguard 5530, has a polyethylene oxide side chain, which makes it reasonable to formulate into WB coatings, ...but this UVA is somewhat dilute not so efficient due to lower active content, 84% only) ...and does not have extremely long term retention (5530 got worse photo-permanence as well) in the field. Water dispersed UVAs like Chiguard 5582 WB or 5400 WB are easy to formulate with, but do not react in to the polymer network, ...so the possibility of migration loss remains.