

INDUSTRIAL TESTING LABORATORY

Report No.: 210702-01Er1

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**TEST REPORT**

Report Date: 03 August 2021  
Revision 1 Date: 17 December 2021 [added Xenon Weathering data]

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

Submitted by: Changzhou Hua R Sheng Reflective Material Co., Ltd  
Zouqu Town, Changzhou 213144 China


Test Laboratory: Calcoast - ITL  
San Leandro, CA 94577


Samples submitted: TM9200 White, TM9200 Yellow, TM9200 Red, TM9200 Green,  
TM9200 Blue  
each submitted 02 July 2021 as five (5) 12 in x 12 in  
sheets

**SUMMARY**

Specification: ASTM D4956-19  
Sheeting Type IV, Class 1 Backing

- 6.2 Coefficient of Retroreflection .....Passed
- 6.3 Daytime Color and Luminance .....Passed
- 6.4 Outdoor Weathering (36 months) .....Not Tested
- 6.5 Colorfastness [Artificial Accelerated Weathering Based] .....Passed
- 6.6 Shrinkage .....Passed
- 6.7 Flexibility .....Passed
- 6.8 Liner Removal .....Passed
- 6.9 Adhesion .....Passed
- 6.10 Impact Resistance .....Passed
- 6.11 Nighttime Color .....Passed
- S3. Artificial Accelerated Weathering (2000 hours) .....Passed

Written by:  
  
Douglas G. Cummins  
Photometric Engineer

Approved by:  
  
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Laboratory Director

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**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.2 Coefficient of Retroreflection**

Requirement: ASTM D4956 Table 5 (Type IV Sheeting)  
Test Method: ASTM E810 - Test Distance 100 feet (30.5 m)  
Entrance angle =  $\beta_1$ .  $\beta_2 = 0$ . Observation Angle =  $\alpha$   
Projector: Hoffman GPS-102 (Illuminant A, 1.0 fc, 30 in. diameter)  
Sample Area: 8.0 in. x 8.0 in., 0.444 ft<sup>2</sup> (203 mm x 203 mm, 0.0412 m<sup>2</sup>)

Sheeting specimens mounted to 0.040 in. thick x 8 in. x 8 in. 6061-T6 aluminum panels.

Coefficient of Retroreflection ( $R_A$ ) determined by measuring three samples at two rotation angles ( $\varepsilon=0^\circ$  and  $\varepsilon=90^\circ$ ) and averaging. Sheeting has no datum mark to indicate  $\varepsilon=0^\circ$ .

$\varepsilon=0^\circ$  arbitrarily defined as orientation with sheeting diamonds' long axis parallel to projector/detector half-plane (see photos).

Tested in accordance to ASTM E810 10.7.1 - since no rotation angle is specified the average of the two orientations ( $\varepsilon=0^\circ$  and  $\varepsilon=90^\circ$ ) is required to meet minimum requirements.

Submitter states sampling performed in accordance with D4956 Section 9.1. Samples taken from submitted specimens labeled "Diagonal" by submitter.

Units: Candela per footcandle per square foot (Candela per Lux per square meter)

**0.2° Observation Angle**

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg. ( $R_A$ )	Min $R_A$	0°	90°	Avg. ( $R_A$ )	Min $R_A$
TM9200 White	#1	526.4	554.2	540.3	288	289.2	314.9	302.1	136
	#2	500.4	515.0	507.7	288	286.8	314.0	300.4	136
	#3	513.9	544.6	529.3	288	299.9	330.3	315.1	136
	Avg.	513.6	537.9	<b>525.8</b>	360	292.0	319.7	<b>305.9</b>	170
TM9200 Yellow	#1	399.5	404.2	401.9	216	246.2	267.3	256.8	108
	#2	410.4	389.3	399.9	216	226.7	262.9	244.8	108
	#3	377.6	344.8	361.2	216	218.6	244.6	231.6	108
	Avg.	395.8	379.4	<b>387.6</b>	270	230.5	258.3	<b>244.4</b>	135
TM9200 Green	#1	73.6	65.4	69.5	40	38.7	49.2	44.0	20
	#2	63.6	64.8	64.2	40	43.8	27.1	35.5	20
	#3	72.6	74.2	73.4	40	45.2	31.8	38.5	20
	Avg.	69.9	68.1	<b>69.0</b>	50	42.6	36.0	<b>39.3</b>	25
TM9200 Red	#1	124.7	134.6	129.7	52	73.6	72.2	72.9	24
	#2	122.0	128.0	125.0	52	52.3	65.9	59.1	24
	#3	120.0	125.9	123.0	52	73.4	70.8	72.1	24
	Avg.	122.2	129.5	<b>125.9</b>	65	66.4	69.6	<b>68.0</b>	30
TM9200 Blue	#1	32.2	33.9	33.1	24	15.0	20.4	17.7	11
	#2	27.4	30.3	28.9	24	22.4	18.2	20.3	11
	#3	26.9	31.8	29.4	24	22.7	21.5	22.1	11
	Avg.	28.8+	32.0	<b>30.4</b>	30	20.0	20.0	<b>20.0</b>	14

+ performance at rotation angle below specified minimum. Average of 0° and 90° rotation angles passed.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.2 Coefficient of Retroreflection (continued)**

0.5° Observation Angle

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg. (R <sub>A</sub> )	Min R <sub>A</sub>	0°	90°	Avg. (R <sub>A</sub> )	Min R <sub>A</sub>
TM9200 White	#1	327.7	307.0	317.4	120	156.1	200.1	178.1	58
	#2	309.2	301.5	305.4	120	198.2	179.3	188.8	58
	#3	322.5	319.5	321.0	120	205.6	194.9	200.3	58
	Avg.	319.8	309.3	<b>314.6</b>	150	186.6	191.4	<b>189.0</b>	72
TM9200 Yellow	#1	235.7	246.9	241.3	88	160.8	147.8	154.3	43
	#2	243.5	261.9	252.7	88	157.2	147.1	152.2	43
	#3	242.5	250.0	246.3	88	153.9	142.4	148.2	43
	Avg.	240.6	252.9	<b>246.8</b>	110	157.3	145.8	<b>151.5</b>	54
TM9200 Green	#1	49.5	45.1	47.3	17	27.8	26.5	27.2	8.0
	#2	48.2	44.4	46.3	17	22.2	22.7	22.5	8.0
	#3	50.0	46.3	48.2	17	24.6	25.4	25.0	8.0
	Avg.	49.2	45.3	<b>47.3</b>	21	24.9	24.9	<b>24.9</b>	10
TM9200 Red	#1	67.5	66.1	66.8	21.6	41.8	39.5	40.7	10.4
	#2	63.0	60.8	61.9	21.6	27.8	35.0	31.4	10.4
	#3	62.8	61.9	62.4	21.6	40.8	38.4	39.6	10.4
	Avg.	64.4	62.9	<b>63.7</b>	27.0	36.8	37.6	<b>37.2</b>	13.0
TM9200 Blue	#1	26.3	30.8	28.6	10	13.6	14.0	13.8	4.8
	#2	22.2	27.6	24.9	10	10.3	16.7	13.5	4.8
	#3	22.7	28.1	25.4	10	9.7	19.0	14.4	4.8
	Avg.	23.7	28.8	<b>26.3</b>	13	11.2	16.6	<b>13.9</b>	6.0

Individual sample's Coefficient of Retroreflection may be 80% of required so long as average of three samples meets minimum requirement.

Samples meet Coefficient of Retroreflection requirements for Type IV Sheeting as the average of 0° and 90° rotations.

**6.3 Daytime Color and Luminance**

Requirement: ASTM D4956 Tables 2 and 11 (Type IV Sheeting)

Test Method: ASTM E308, E1347, E1349, E991, E1164

(Illuminant D65, 2° Observer, Annular 45/0 Geometry)

Average of 8 reads, each read oriented 45° apart

Samples from 6.2

Instrument: Hunterlab Colorflex Spectrocolorimeter, 32 mm aperture port

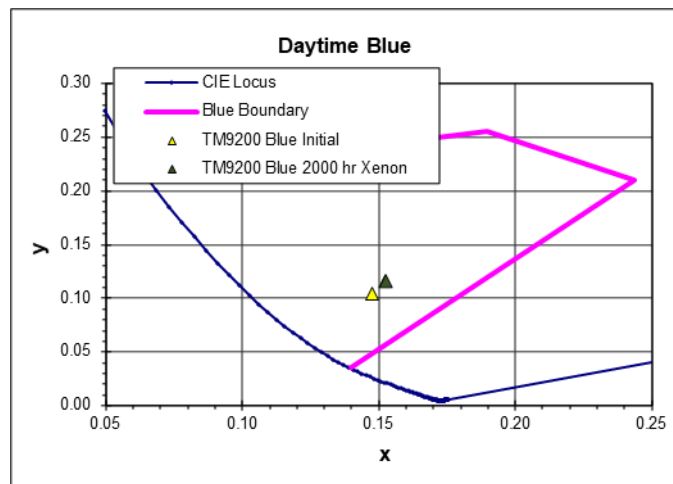
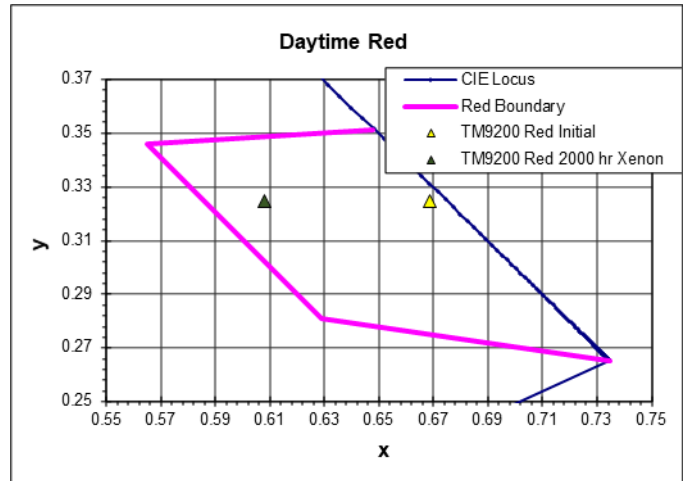
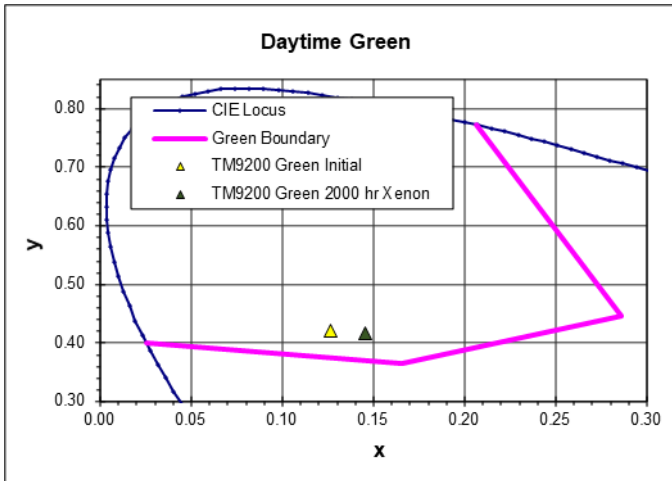
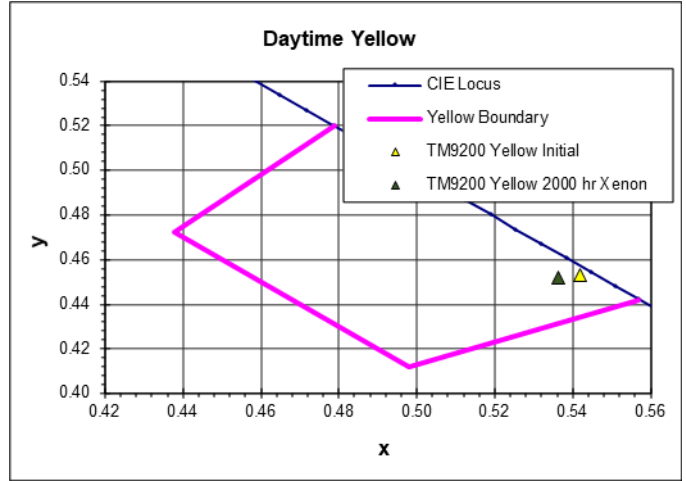
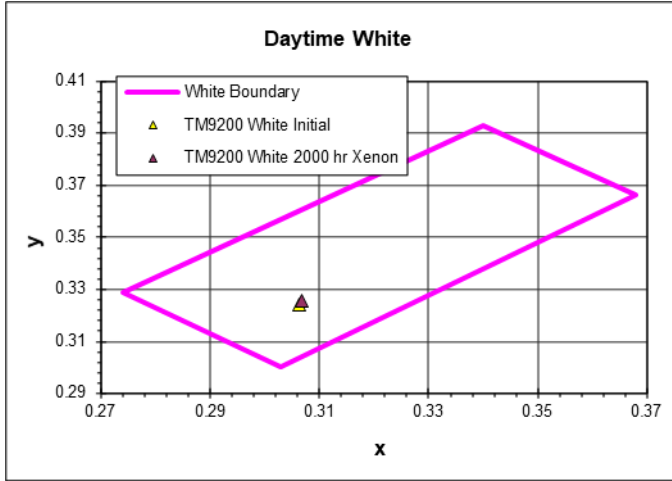
Sample		x	y	Y		
				Measured	Minimum	Maximum
TM9200 White	#1	0.3064	0.3240	50.85	27	-
TM9200 Yellow	#1	0.5419	0.4527	28.11	15	45
TM9200 Green	#1	0.1268	0.4215	6.07	3.0	12
TM9200 Red	#1	0.6689	0.3248	4.29	2.5	15
TM9200 Blue	#1	0.1478	0.1042	3.95	1.0	10

Samples meet Daytime Color and Luminance requirements.  
See next page for Daytime color plots.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
 Retroreflective Sheeting (Type IV)

**Daytime Color Plots**



**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.4 Accelerated Outdoor Weathering**

Not Tested.

**6.5 Colorfastness**

Requirement: ASTM D4956 Tables 2 and 11 (Type IV Sheeting)  
 Exposure: from S3 Artificial Accelerated Weathering  
 Test Method: ASTM E308, E1347, E1349, E991, E1164  
 (Illuminant D65, 2° Observer, Annular 45/0 Geometry)  
 Average of 8 reads, each read oriented 45° apart  
 Instrument: Hunterlab Colorflex Spectrocolorimeter, 32 mm aperture port

Post 2000 hour Artificial Accelerated Weathering (see S3)

Sample		x	y	Y		
				Measured	Minimum	Maximum
White	Xe1	0.3068	0.3257	52.39	27	-
Yellow	Xe1	0.5364	0.4517	30.26	15	45
Green	Xe1	0.1456	0.4153	6.98	3.0	12
Red	Xe1	0.6084	0.3244	3.96	2.5	15
Blue	Xe1	0.1525	0.1155	4.79	1.0	10

See previous page for plots against color boundaries.

Samples meet Colorfastness requirements.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.6 Shrinkage**

Requirement: ASTM D4956 6.6

Test Method: ASTM D4956 7.8

Removed liner from 9 in. x 9 in. samples and measured the sample side lengths at t = 0, t = 10 min, and t = 24 hours then determined the length changes.

Sample	Side	10 minutes		24 hours	
		Measured	Maximum Allowed	Measured	Maximum Allowed
TM9200 White	1	N/C	1/32 in.	N/C	1/8 in.
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TM9200 Yellow	1	N/C	1/32 in.	N/C	1/8 in.
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TM9200 Green	1	N/C	1/32 in.	N/C	1/8 in.
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	
TM9200 Red	1	N/C	1/32 in.	N/C	1/8 in.
	2	N/C		N/C	
	3	N/C		N/C	
	4	-1/64 in		-1/64 in	
TM9200 Blue	1	N/C	1/32 in.	N/C	1/8 in.
	2	N/C		N/C	
	3	N/C		N/C	
	4	N/C		N/C	

N/C indicates no change.

Samples meet Shrinkage requirements.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.7 Flexibility**

Requirement: ASTM D4956 6.7  
Test Method: ASTM D4956 7.9

2¾ in. x 11 in. samples prepared by removing protective liner and liberally applying talc on adhesive side. Samples then bent around ¼ in. diameter mandrel by grasping long ends of sample and placing center of sample at the mandrel with adhesive side contacting mandrel, then pulling long ends downward and together within 1 second until material had a 180° bend at its center. Samples tested in three (3) orientations - 0°, 45°, and 90° as defined for coefficient of retroreflection.

Sample	Results		
	0°	45°	90°
TM9200 White	No cracking.	No cracking.	No cracking.
TM9200 Yellow	No cracking.	No cracking.	No cracking.
TM9200 Green	No cracking.	No cracking.	No cracking.
TM9200 Red	No cracking.	No cracking.	No cracking.
TM9200 Blue	No cracking.	No cracking.	No cracking.

Samples meet Flexibility requirements.

**6.8 Liner Removal**

Requirement: ASTM D4956 6.8  
Test Method: ASTM D4956 7.10

2 in. x 6 in. samples exposed to accelerated storage conditions of 71°C at 2.5 psi for 4 hours then cooled to 23°C for 1 hour.

Sample	Results
TM9200 White	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TM9200 Yellow	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TM9200 Green	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TM9200 Red	Liner easily removed without assistance and did not break, tear, or remove adhesive.
TM9200 Blue	Liner easily removed without assistance and did not break, tear, or remove adhesive.
Fl. Orange	Liner easily removed without assistance and did not break, tear, or remove adhesive.

Samples meet Liner Removal requirements.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.9 Adhesion**

Requirement: ASTM D4956 6.9  
Test Method: ASTM D4956 7.5

4 in. each of two (2) 1 in.x6 in. sheeting samples were bonded to 0.040 in. thick degreased and acid-etched 6061-T6 aluminum panels. After conditioning for a minimum of 24 hours, a 0.79kg weight was hung from the free end of sample 90° to the panel. After 5 minutes, the peel distance was measured.

Sample	Peel Distance		Maximum
	#1	#2	
TM9200 White	0.15 in.	0.17 in.	2.0 in.
TM9200 Yellow	0.15 in.	0.13 in.	
TM9200 Green	0.10 in.	0.11 in.	
TM9200 Red	0.12 in.	0.11 in.	
TM9200 Blue	0.11 in.	0.12 in.	

Samples meet Adhesion requirements.

**6.10 Impact Resistance**

Requirement: ASTM D4956 6.10  
Test Method: ASTM D4956 7.11, D2794

3 in. x 5 in. samples mounted to 0.040 in. thick 6061-T6 aluminum were subjected to a 10 in-lb impact from a mass with a steel 5/8 in. diameter round tip.

Sample	Results
TM9200 White	No cracking or delamination outside impact area.
TM9200 Yellow	No cracking or delamination outside impact area.
TM9200 Green	No cracking or delamination outside impact area.
TM9200 Red	No cracking or delamination outside impact area.
TM9200 Blue	No cracking or delamination outside impact area.

Samples meet Impact Resistance requirements.



**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**6.11 Nighttime Color**

Requirement: ASTM D4956 Table 13  
 Test Method: ASTM E811, E308, E3165  
 (Illuminant A, 2° Observer, +5°/0.33° Geometry at 15 feet)  
 Average of 3 reads at  $\epsilon=0^\circ$  and  $90^\circ$   
 Samples from 6.2  
 Instrument: Photo Research PR-655 Spectroradiometer

## Initial

Sample		$\epsilon=0^\circ$		$\epsilon=90^\circ$	
		x	y	x	y
TM9200 White	#1	0.4641	0.4128	0.4671	0.4133
TM9200 Yellow	#1	0.5550	0.4394	0.5516	0.4425
TM9200 Green	#1	0.1866	0.6298	0.1854	0.6282
TM9200 Red	#1	0.6725	0.3225	0.6728	0.3227
TM9200 Blue	#1	0.1235	0.3048	0.1271	0.3101

## Colorfastness - Post 2000 hr Xenon Weathering (see S3)

Sample		$\epsilon=0^\circ$		$\epsilon=90^\circ$	
		x	y	x	y
TM9200 White	Xe1	0.4633	0.4134	0.4635	0.4132
TM9200 Yellow	Xe1	0.5552	0.4391	0.5531	0.4409
TM9200 Green	Xe1	0.1873	0.6280	0.1857	0.6250
TM9200 Red	Xe1	0.6704	0.3239	0.6703	0.3243
TM9200 Blue	Xe1	0.1233	0.3060	0.1291	0.3118

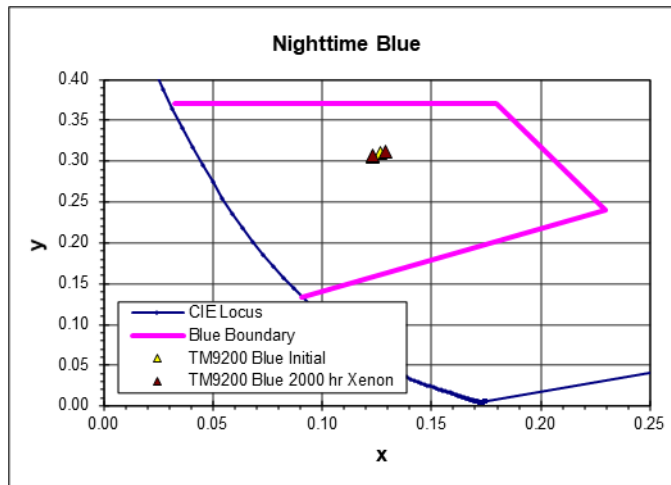
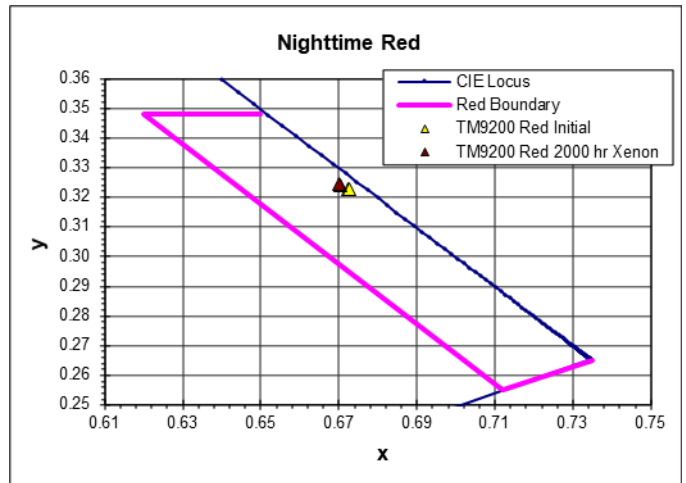
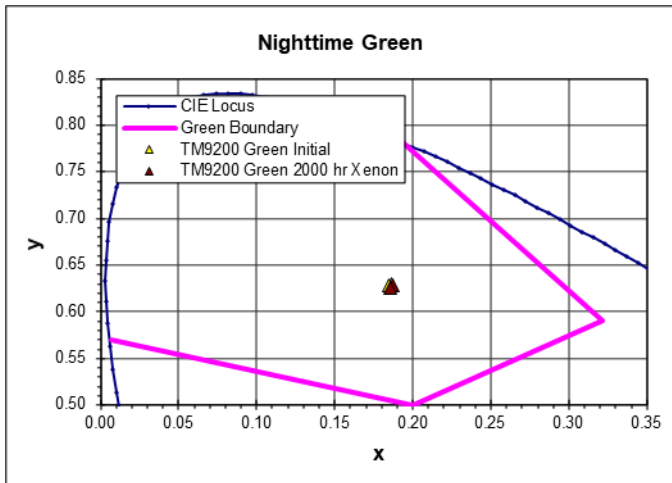
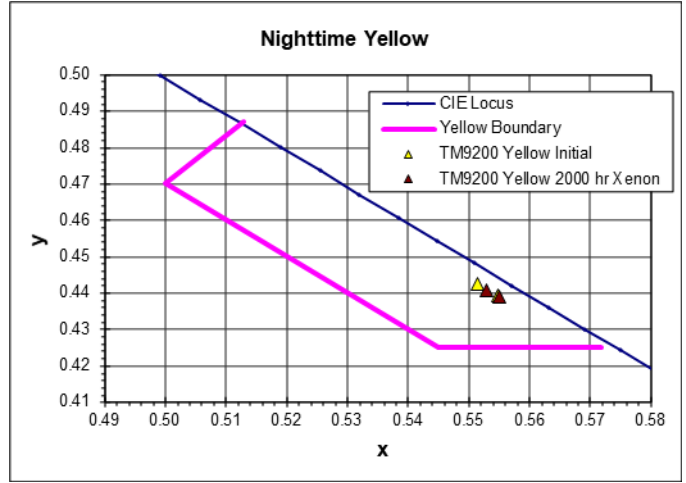
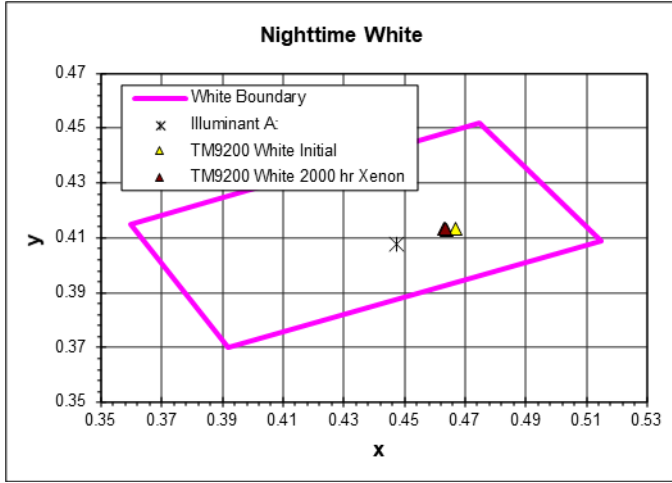
Samples meet Nighttime Color requirements.  
See next page for Nighttime color plots.

Note: Colorfastness of Nighttime Color is not explicitly required for ASTM D4956.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
 Retroreflective Sheeting (Type IV)

**Nighttime Color Plots**



**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

**S3. Artificial Accelerated Weathering**

Requirement: 80% of ASTM D4956 Table 5 (Type IV), 0.2° observation only  
Exposure: ASTM D4956 S3, Method III  
(ISO 4892-2:2006/Amd.1:2009, Cycle 1) - 2000 hours;  
Exposure Lab: ARDL, report #: PN 161151  
Test Method: ASTM E810 - Test Distance 100 feet (30.5 m)  
Sample Area: 3.0 in. x 5.5 in., 0.115 ft<sup>2</sup> (76 mm x 140 mm, 0.0106 m<sup>2</sup>)  
Projector: Hoffman GPS-102 (Illuminant A, 1 fc, 30 in. diameter)

Sheeting specimens mounted to 0.040 in. thick x 3 in. x 6 in. 6061-T6 aluminum panels and exposed to Xenon Accelerated Weathering for the specified time. After exposure, samples were washed in a mild detergent solution and dried prior to measuring.

During weathering, samples held in place by top edge of the panel. The top 0.5 in. x 3.0 in. was masked to cover the unexposed area. Samples' Coefficient of Retroreflection was then measured at two rotation angles ( $\epsilon=0^\circ$  and  $\epsilon=90^\circ$ ) and averaged.

Units: Candela per footcandle per square foot (Candela per Lux per square meter)

Entrance Angle:		-4°				+30°			
Sample		0°	90°	Avg. (R <sub>A</sub> )	Min R <sub>A</sub>	0°	90°	Avg. (R <sub>A</sub> )	Min R <sub>A</sub>
TM9200 White	#1	426.6	417.6	422.1	288	212.2	267.4	239.8	136
	#2	412.7	414.6	413.7		197.8	252.1	225.0	
	#3	428.3	413.1	420.7		218.6	257.4	238.0	
	Avg.	422.5	415.1	<b>418.8</b>		209.5	259.0	<b>234.3</b>	
TM9200 Yellow	#1	275.0	267.6	271.3	216	152.8	137.5	145.2	108
	#2	324.7	313.5	319.1		204.5	168.2	186.4	
	#3	325.1	318.8	322.0		230.7	222.5	226.6	
	Avg.	308.3	300.0	<b>304.1</b>		196.0	176.1	<b>186.0</b>	
TM9200 Green	#1	49.9	50.6	50.3	40	32.5	20.1	26.3	20
	#2	53.7	49.5	51.6		22.2	37.7	30.0	
	#3	53.9	47.2	50.6		29.1	35.7	32.4	
	Avg.	52.5	49.1	<b>50.8</b>		27.9	31.2	<b>29.6</b>	
TM9200 Red	#1	86.1	88.8	87.5	52	47.1	47.3	47.2	24
	#2	89.9	92.2	91.1		49.2	51.0	50.1	
	#3	76.9	77.3	77.1		43.8	43.4	43.6	
	Avg.	84.3	86.1	<b>85.2</b>		46.7	47.2	<b>47.0</b>	
TM9200 Blue	#1	22.3+	26.1	24.2	24	15.6	18.1	16.9	11
	#2	25.0	26.5	25.8		9.4+	16.4	12.9	
	#3	23.6+	24.8	24.2		8.7+	17.5	13.1	
	Avg.	23.6+	25.8	<b>24.7</b>		11.2	17.3	<b>14.3</b>	

+ performance at rotation angle below specified minimum. Average of 0° and 90° rotation angles passed.

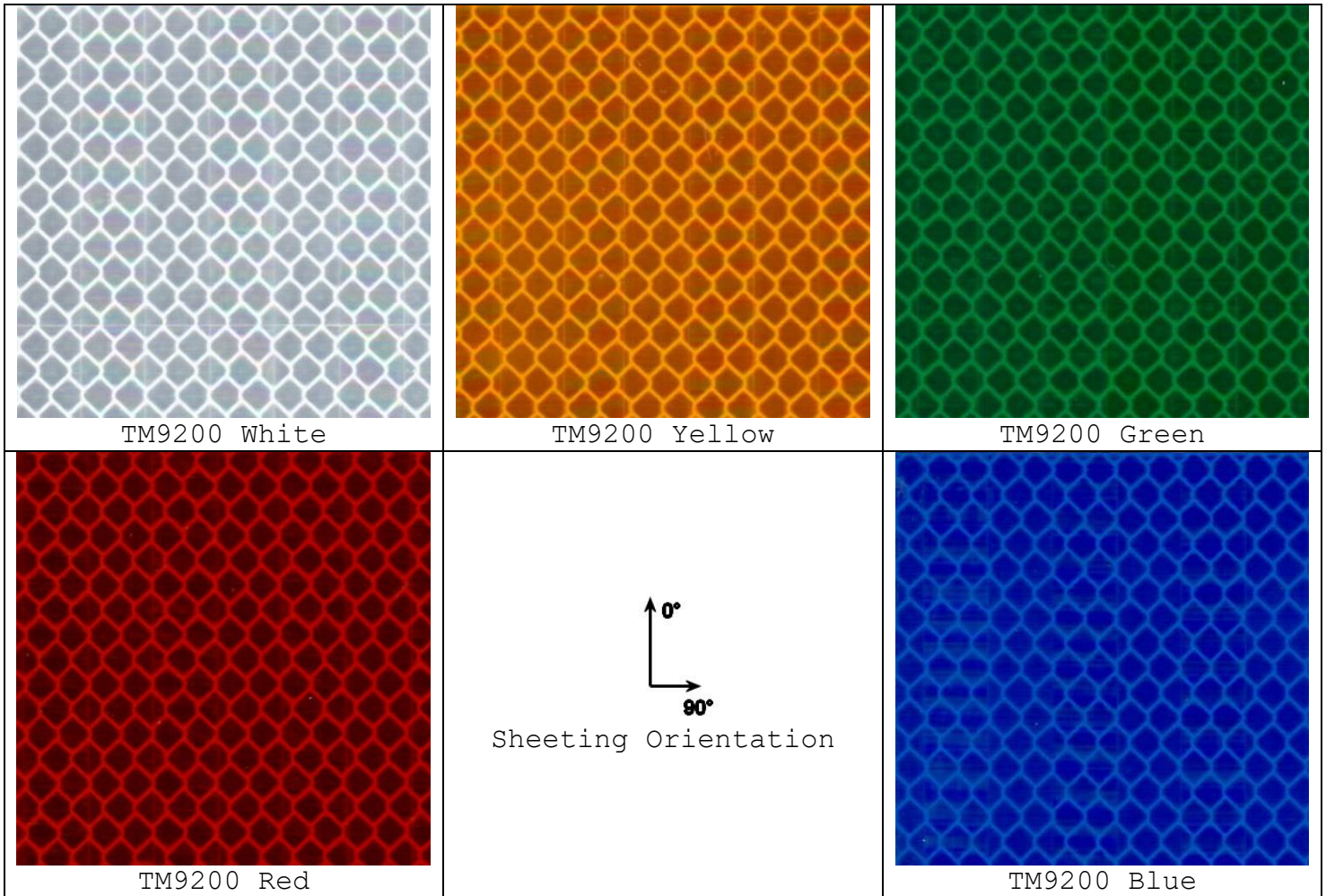
Samples show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than 1/32 in. shrinkage or expansion.

Samples meet Artificial Accelerated Weathering requirements.

**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

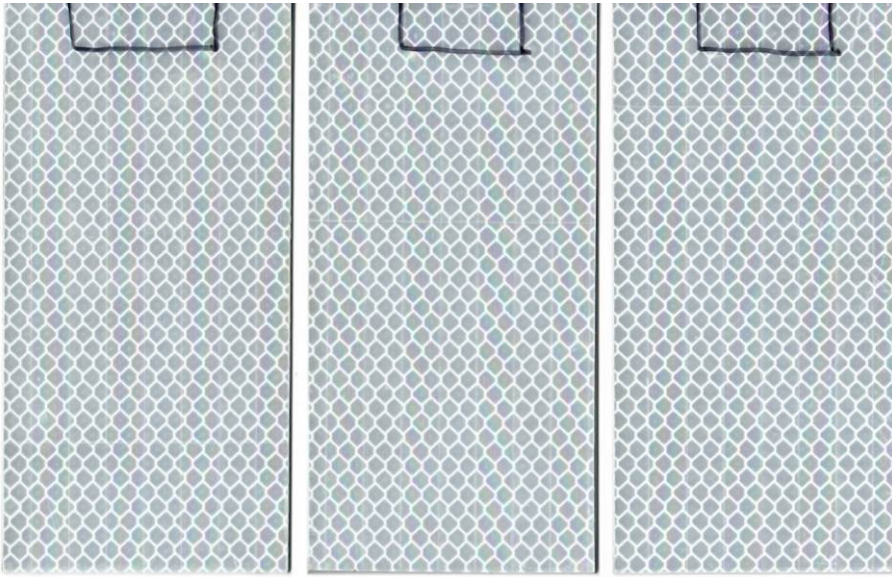
**Photographs**



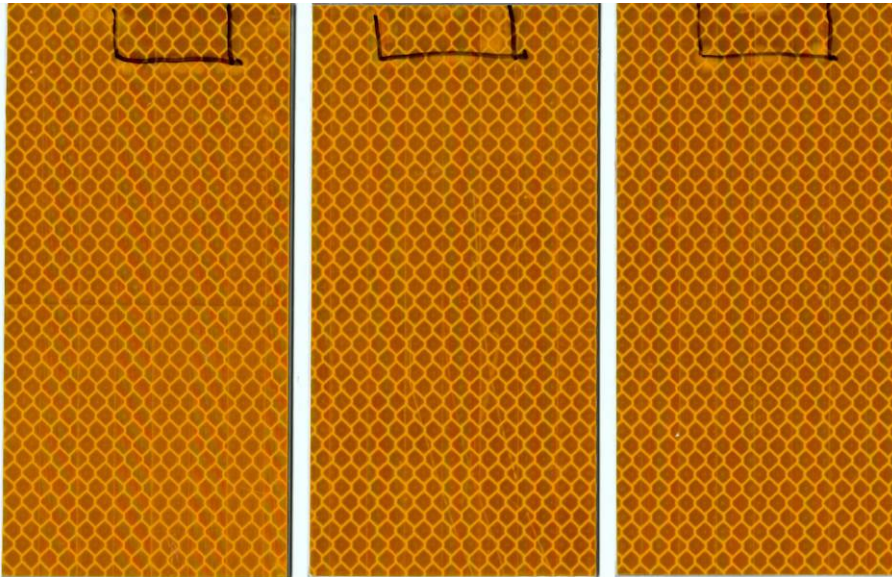
**TEST DATA SHEET**

Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)

2000 hr Xenon Weathered samples



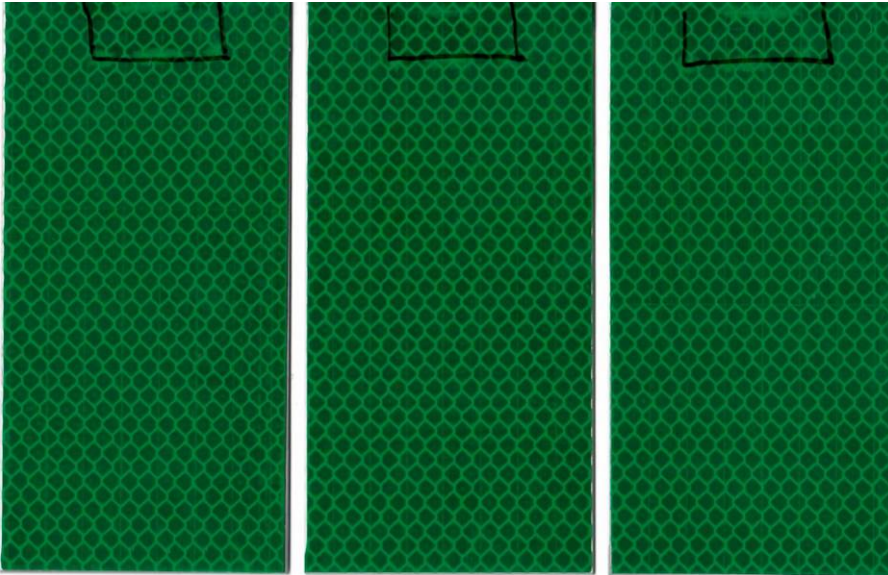
TM9200 White



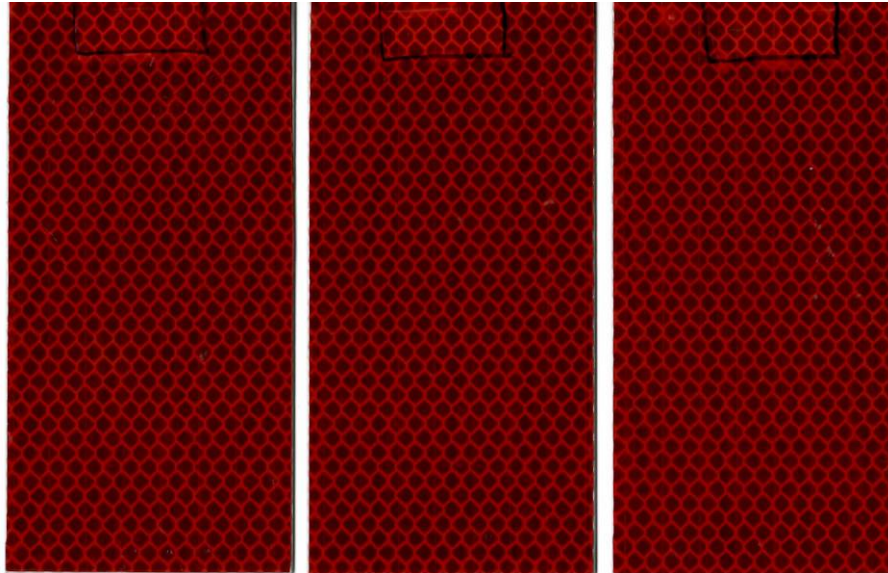
TM9200 Yellow

**TEST DATA SHEET**

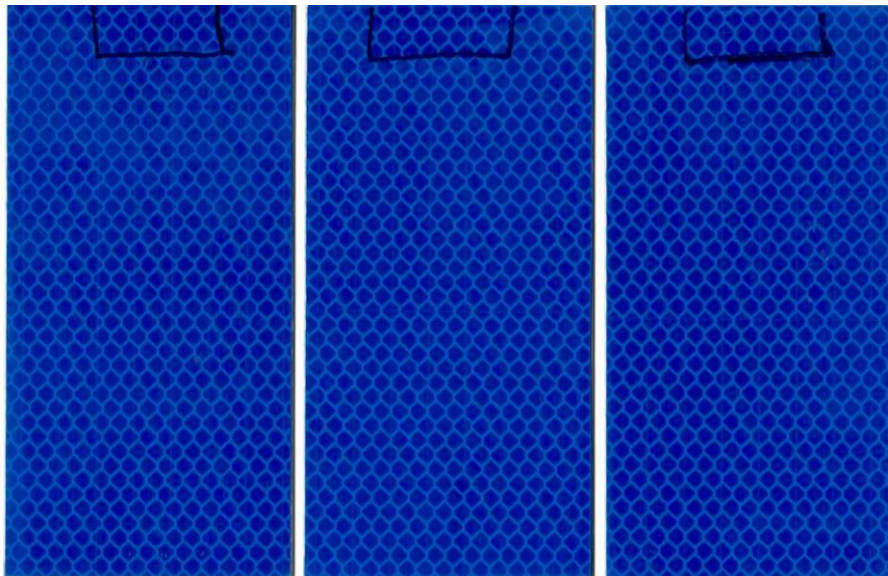
Project Name: Hua R Sheng TM 9200 Series Sheeting  
Retroreflective Sheeting (Type IV)



TM9200 Green



TM9200 Red



TM9200 Blue