MICOM INC.
LABORATOIRES · LABORATORIES

April 22, 2020

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CANADA

TEST REPORT # MI-19-11614-2

On September 13th 2019, Micom Laboratories Inc. received 1 sample to perform accelerated Light Aging.

SAMPLE DESCRIPTION:

- Sample 1 : Palmex Leaves (2846)

Sample 1

<u>REFERENCE TEST METHOD</u>:

Samples were exposed as per ASTM G155 Cycle 1 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.
The cycle consists of 102 min Light followed by 18 min Light and water spray (Air temp. not controlled).
Conditions in the Xenon Light chamber:

- Irradiance: 0.35 ± 0.02 W/m^2 @ 340 nm
- Filters: Daylight Filter (Borosilicate Inner/Borosilicate Outer Filter)
- Black panel: 63 ± 2.5 °C

Exposure duration: 4000hrs.
Samples were exposed: ☒ As received ☐ Preparation: - - - -

Type of equipment used with Xenon Arc emission lamp

Samples were rated according to:

- ASTM D523 (Specular Gloss)
- ASTM D2244 (Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates)

Note: The samples were not standard, therefore the colors and gloss measurements will be given as an indication. (*The samples submitted were curved with not uniform colors. We refer as standard by flat panels with uniform colors)*

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RESULTS:

Tests performed between 2019-10-08 and 2020-04-22.

Sample	Exposition total hrs	Initials values		ASTM G155	
		L*	a*	b*	Gloss 60°
#1 Base	4000	46.8	4.4	13.8	2.4
#1 Leaf	4000	54.6	4.8	17.9	0.3

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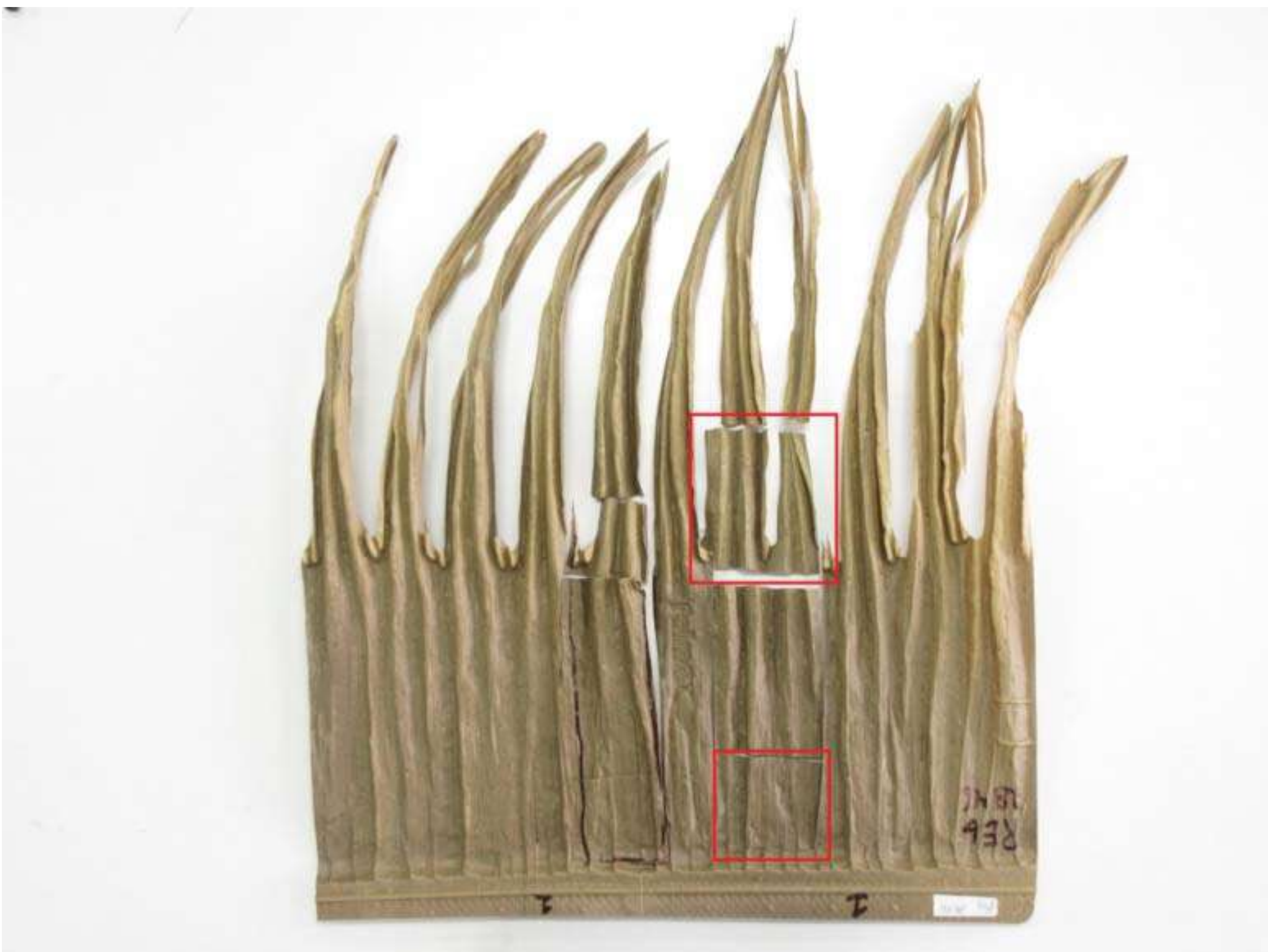
- **1000hrs**

Sample	1000 hrs	ASTM G155			ΔL*	Δa*	Δb*	ΔE^*_{ab}	ΔGloss
	L*	a*	b*	Gloss 60°					
#1 Base	47.1	4.4	13.8	3.5	0.3	0.0	0.1	**0.3**	**1.1**
#1 Leaf	54.5	5.1	17.7	0.5	-0.1	0.2	-0.1	**0.3**	**0.2**



Sample 1 after 1000hrs exposure

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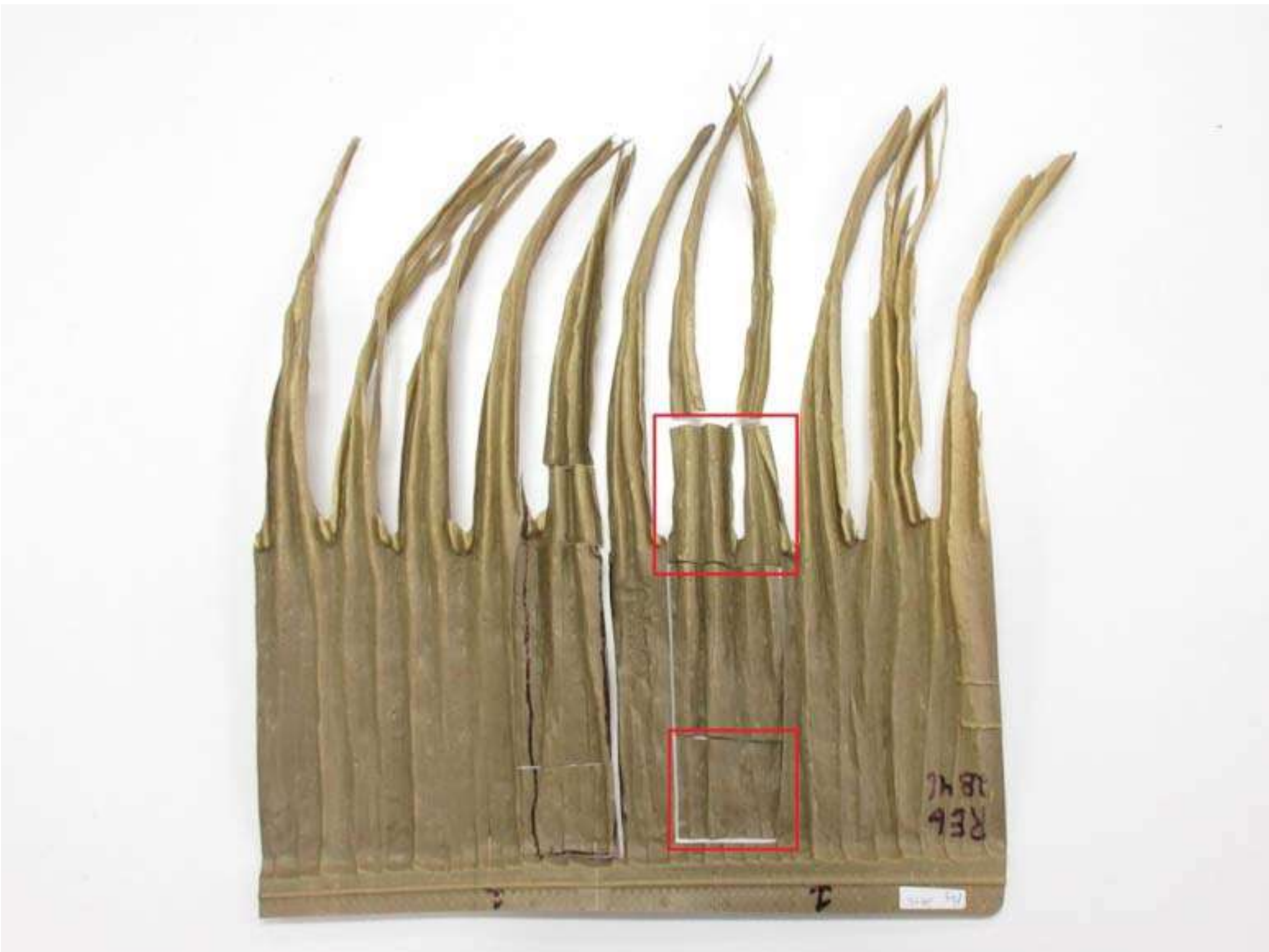
- **2000hrs**

Sample	2000 hrs ASTM G155				ΔL*	Δa*	Δb*	ΔE^*_{ab}	ΔGloss
	L*	a*	b*	Gloss 60°					
#1 Base	46.2	4.3	13.6	3.6	-0.6	-0.1	-0.1	**0.6**	**1.2**
#1 Leaf	55.0	5.1	18.0	1.4	0.5	0.3	0.1	**0.5**	**1.1**



Sample 1 after 2000hrs exposure

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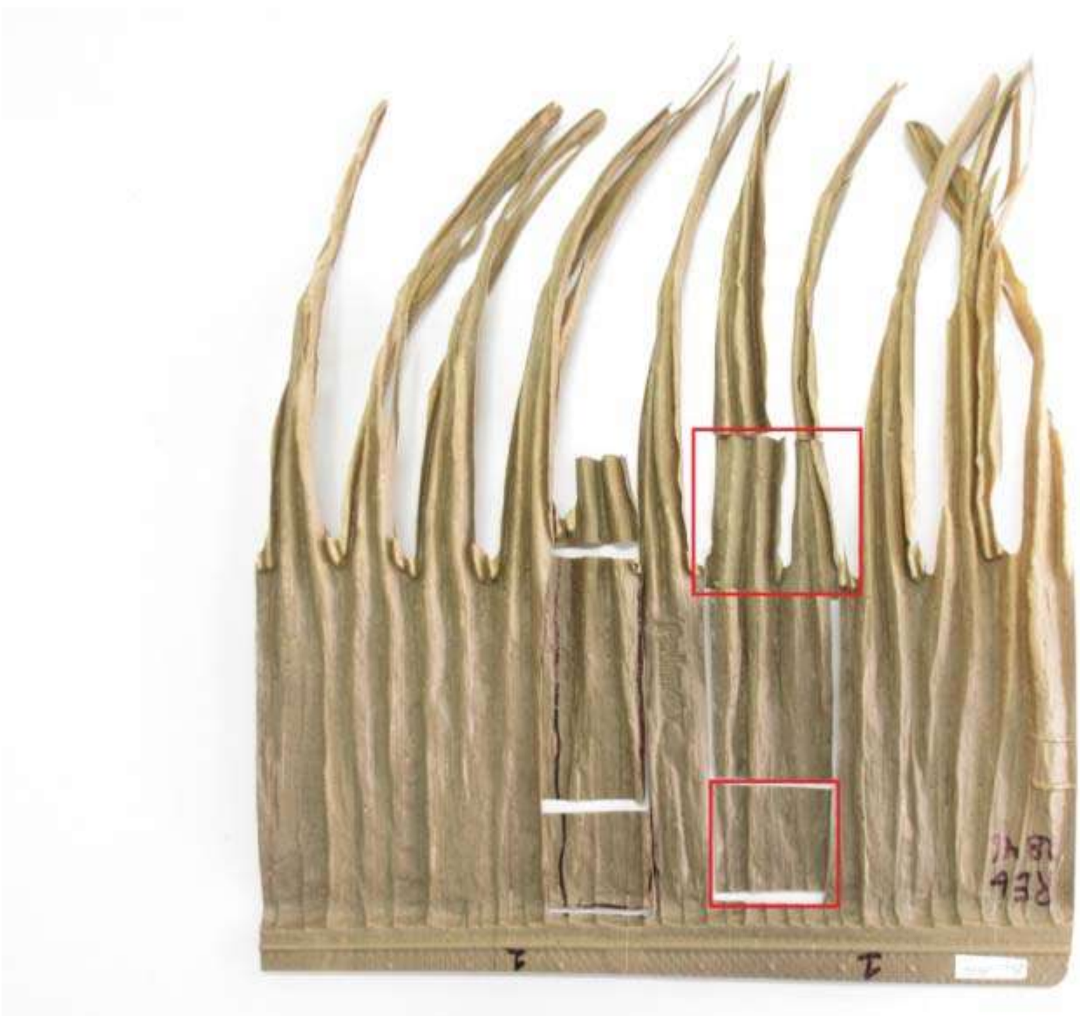
- **3000hrs**

Sample	3000 hrs	ASTM G155			ΔL*	Δa*	Δb*	ΔE*ab	ΔGloss
	L*	a*	b*	Gloss 60°					
#1 Base	47.1	4.3	13.2	3.8	0.3	-0.1	-0.6	**0.7**	**1.4**
#1 Leaf	52.6	5.0	16.6	1.2	-1.9	0.2	-1.2	**2.3**	**0.9**



Sample 1 after 3000hrs exposure

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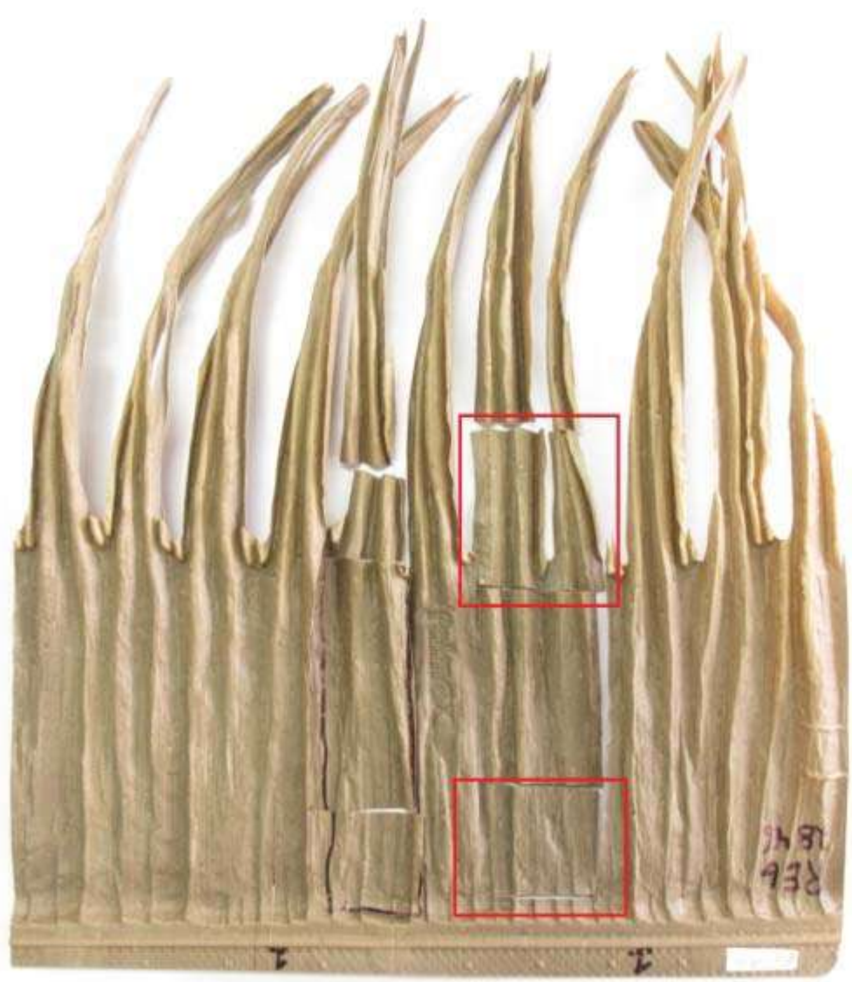
- **4000hrs**

Sample	4000 hrs	ASTM G155			ΔL*	Δa*	Δb*	ΔE^*_{ab}	ΔGloss
	L*	a*	b*	Gloss 60°					
#1 Base	46.3	4.1	13.0	3.9	-0.5	-0.3	-0.7	**0.9**	**1.5**
#1 Leaf	54.8	4.8	17.3	1.4	0.2	0.0	-0.6	**0.6**	**1.1**



Sample 1 after 4000hrs exposure

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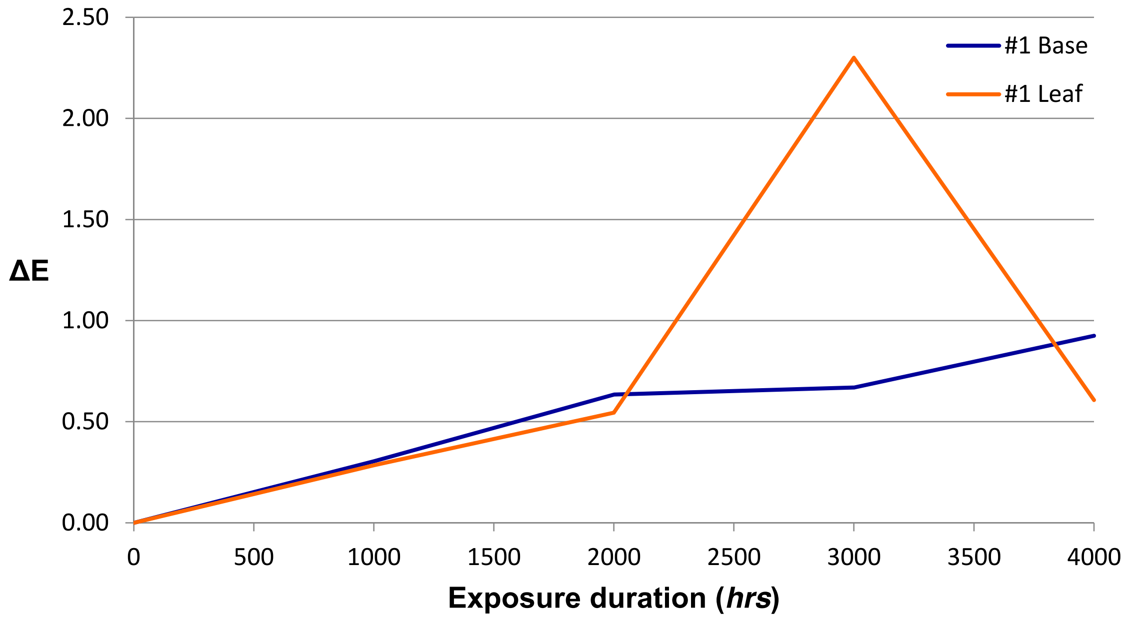

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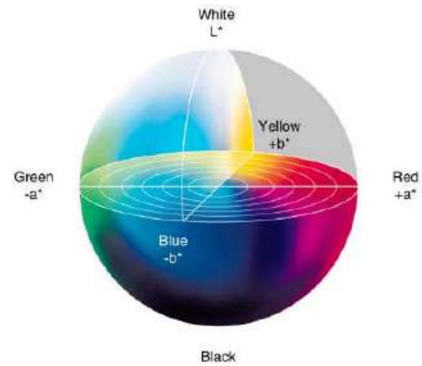
APPENDIX 1: Color & ΔE

L*.a*.b* values: color measurement

L*.a*.b*. coordinates refer to the coordinates of the color in the CIELAB 76 sphere. It is actually a three-dimensional space where the L* axis represents the "lightness" of the color (Black to white), a* is the green-red axis and b* is the blue-yellow axis. L* axis goes from 0 (darkest black) to 100 (brighter white), a* goes from -100 (green) to + 100 (red), b* goes from -100 (blue) to + 100 (yellow)[1].



ΔE (Delta E): Color difference measurement

In order to quantify the difference between 2 colors, a formula that measures the distance between the 2 colors was established and called ΔE (Delta E). The formula used to determine the distance between color 1 (L_1*, a_1*, b_1*) and color 2 (L_2*, a_2*, b_2*) is:

$\Delta E = [\, (L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2 \,]^{0.5}$

It was found that the *Just Noticeable Difference (JND)*[2] is, for most people, at ΔE = 2.3. That means that the magnitude of difference between 2 colors must be 2.3 or more to be noticed. Over the years, some industries came up with their own JND value based on specific needs and applications. The 2.3 value is, however, still widely used as the JND.
Other rating scales can also be found in the literature:

Scale #1[3]:
$0.0 < \Delta E \leq 0.5$: No color difference
$0.5 < \Delta E \leq 1.0$: Difference only perceivable for experienced observers
$1.0 < \Delta E \leq 2.0$: Minimal color difference
$2.0 < \Delta E \leq 4.0$: Perceivable color difference
$4.0 < \Delta E \leq 5.0$: Significant color difference
$5.0 < \Delta E$: Different colors

Scale #2[4]:
$0 < \Delta E \leq 1$: Observer does not notice the difference
$1 < \Delta E \leq 2$: Only experienced observer can notice the difference
$2 < \Delta E \leq 3.5$: Inexperienced observer can notice the difference
$3.5 < \Delta E \leq 5$: Clear difference in color is noticed
$5 < \Delta E$: Observer notices two different colors

[1] *a* and b* axis can technically go further than the usual ± 100 range but it never really happens in practice.*
[2] *Mahy et al. (1994)*
[3] *Published by Dr Bela Torok, M.D., Ph.D. (Ophthalmologist) on ResearchGate.net*
[4] *From « colour difference ΔE – A survey » by Mokrzycki W.S., Tatol M., University of Warmia and Mazury, August 2012.*

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