

## TEST REPORT

Report Number: 241592  
Date of Issue: October 23, 2024

Report to:


**Hanwha Vision Co., Ltd**

6, Pangyo-ro 319beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13488, Korea

Reported by:

**Chemitox, Inc., Shinjyo Testing Center**

Shinjyo-Yokoneyama-Kogyo-Danchi, 4102-8, Aza-Takadaishinden, Oaza Izumida, Shinjyo-Shi  
Yamagata-Ken, 999-5103, Japan



Responsible Officer

Hitoshi Watanabe

Chief of Shinjyo testing center

- (1) Chemitox is accredited by the following agency to ISO/IEC 17025.  
American Association for Laboratory Accreditation (A2LA) — Certificated No: 1136.08
- (2) This TEST REPORT refers only to the sample tested, unless stated otherwise.

**Hanwha Vision Co., Ltd**

6, Pangyo-ro 319beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, 13488, Korea

## Oxygen Index Measurement Test Report

### 1. Objective

As per client's request, Oxygen Index Measurement is conducted in accordance with ISO 4589-2:2017 "Plastics -- Determination of burning behaviour by oxygen index -- Part 2: Ambient-temperature test".

### 2. Test Date

October 22, 2024

### 3. Test Conditions

See individual test datasheet

### 4. Description of Test Specimens

The description of the specimens given in **Table 1** has been prepared from information provided by Hanwha Vision Co., Ltd. This information has not been independently verified by Chemitox. All values quoted are nominal, unless specified.

**Table 1** Description of specimens

Material Composition	Product Name	Color	Nominal Dimension (mm)	Qty.	Received on
Silicone rubber	Thermal PAD	light blue	140×52×2	36	October 3, 2024

### 5. Sampling

The specimens were supplied by the client. Chemitox was not involved in any sampling procedure. The results stated in this report apply to the specimens as received from the client.

Note: Sampling means the prescribed procedure for extracting a part of a substance, material, or product to provide a representative specimen for testing.

## 6. Test Method and Conditioning

Test Method and Conditioning is indicated in Table 2.

**Table 2** Test Method and Conditioning

<b>Test name</b>	Oxygen Index Measurement
<b>Test and Classification method</b>	ISO 4589-2:2017
<b>Test Flame</b>	Procedure B – Propagating ignition
<b>Sample conditioning</b>	Specimens are conditioned to be stabilized constant mass or at least 88h at 23±2°C/50±5 %RH

## 7. Test Results

Summarized test results is shown in Table 3.  
See Appendix for details.

**Table -3** : Test Results

<b>Sample</b>	<b>Oxygen Index OI (%) *1 *2</b>
Thermal PAD	>80.0 *3

\*1: When performing a measurement and subsequently making a statement of conformity, for example Pass/Fail to a particular requirement, Simple Acceptance Rule is used which is same as Upper/Lower Specification . (Please see “Guidance for decision rule” in detail.)

\*2: the test results relate only to the behavior of the test specimens under the conditions of this test and that these results shall not be used to infer the fire hazards of the materials in other forms or under other fire conditions

\*3: When the oxygen concentration was increased to 80.0%, the response was “○”.  
The oxygen concentration higher than 80.0% is dangerous.  
For safety reasons, the upper limit of the oxygen concentration at the test is 80.0%, and the result is reported as “> 80.0%”.

## 8. Test Location

Chemitox, Inc., Shinjyo Testing Center  
Shinjyo-Yokoneyama-Kogyo-Danchi, 4102-8, Aza-Takadaishinden, Oaza Izumida, Shinjyo-Shi  
Yamagata-Ken, 999-5103, Japan

## 9. Performed by

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Yutaro Kurosaki

Yutaro Kurosaki, Team Leader Shinjyo testing center (Level 3)

## 10. Reviewed by

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Hitoshi Watanabe

Hitoshi Watanabe, Chief of Shinjyo testing center

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## Guidance for decision rule

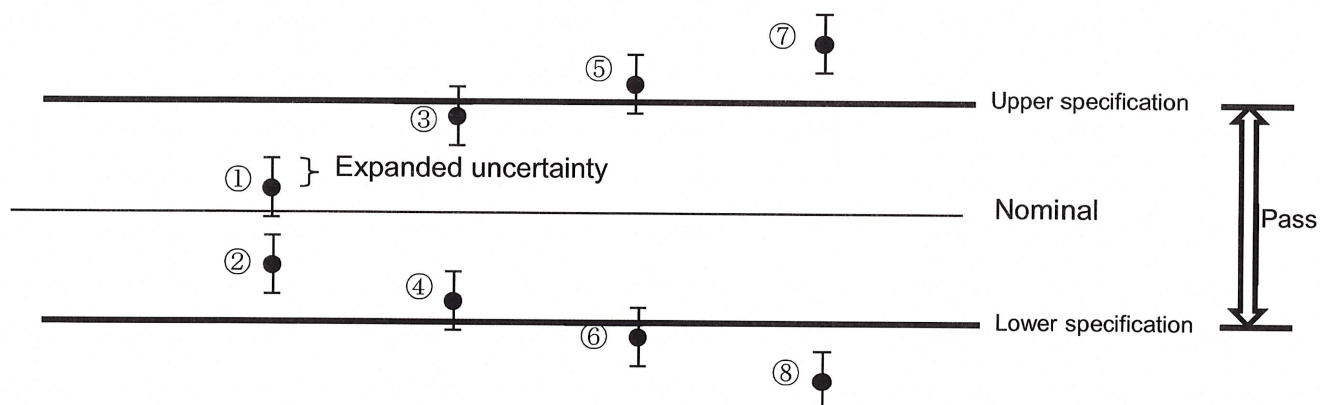
Issued: 2021-11-29  
Revised: 0000-00-00

When performing a measurement and subsequently making a statement of conformity, for example Pass/Fail to a particular requirement, decision rule should be made to make a correct decision regarding conformance to specification or requirement.

In case of Chemitox, we use Simple Acceptance Rule, unless customers request or test standard specifically requests otherwise. Simple Acceptance Rule is the acceptance limit is the same as Upper/Lower Specification. This means the guard band is zero.

### What means the guard and is zero

Since no adjustment is made to make a decision, decision for conformance or classification is made using the measured test value. In the figure below, uncertainty is indicated, but not uncertainty is considered when making a judgement.



In this case, the result will be

	①, ②	③, ④	⑤, ⑥	⑦, ⑧
<b>Simple Acceptance</b>	<b>Pass</b>	<b>Pass</b>	<b>Fail</b>	<b>Fail</b>

Reference: ILAC G8: Guidelines on Decision Rules and Statements of Conformity

## Appendix

(4 Pages including this page)

- Oxygen Index Measurement test data
- Oxygen Index Measurement test method

Oxygen Index Test Result

Ref. No.: 241592  
Test Date: 2024/10/22  
Product Name: Thermal PAD  
Specimen form: Type V L: 140 mm W: 52 mm T: 2 mm  
Color: light blue  
Test chimney Diameter: 75mm  
Room Temperature: 22 °C  
Relative Humidity: 54 %  
Ignition Procedure: Procedure B – Propagating ignition  
Chimney Inside Temp.: 23 °C  
Ox. Conc. Change Interval (d): 0.2 %  
Test method: ☐JIS K6269 ☐JIS K7201-2 ☐ASTM D2863 ☒ISO4589-2 ☐other

TP-48-R3  
Issued : 2005-07-29  
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A. Determination of preliminary volume fraction of oxygen

Oxygen volume fraction (%)	28.0	36.0	52.0	68.0	80.0				
Burning period (s)	0.0	0.0	0.0	0.0	0.0	OI > 80.0% *			
Length burnt (mm)	0.0	0.0	0.0	0.0	0.0				
Response (○ or ×)	○	○	○	○	○				

B. Determination of Oxygen Index

Found that differ by d = 0.2% and of which

Measurement			*: When the oxygen concentration was increased to 80.0%, the response was "○". The oxygen concentration higher than 80.0% is dangerous. For safety reasons, the upper limit of the oxygen concentration at the test is 80.0%, and the result is reported as "> 80.0%".	ns	Cf
Oxygen Concentration (%)					
Burning Time (s)					
Burned Length (mm)					
Response (○ or ×)					
* COLUMN (2, 3, 4 or 5):			0	2024-10-22 yk	* ROW(1to16): 0
				k	= 0

OI =  $C_f + k \cdot d$  = + ( 0.00 × 0.2 )  
= #VALUE! (To Calculate Standard Deviation; two decimal places)  
= 0.0 % (To Report; one decimal place)

C. Verification of step size d% oxygen volume fraction

Last Six Specimens' Results		Oxygen Concentration (%)			
		$C_i$	OI	$C_i - OI$	$(C_i - OI)^2$
Cf	1		#VALUE!	#VALUE!	#VALUE!
	2		#VALUE!	#VALUE!	#VALUE!
	3		#VALUE!	#VALUE!	#VALUE!
	4		#VALUE!	#VALUE!	#VALUE!
	5		#VALUE!	#VALUE!	#VALUE!
n	6	0.0	#VALUE!	#VALUE!	#VALUE!
		$\sum (C_i - OI)^2 =$		#VALUE!	

Estimation of Standard Deviation

$$\hat{\sigma} = \left[ \frac{\sum (c_i - OI)^2}{n - 1} \right]^{1/2} = \text{\#VALUE!}$$
$$\frac{2\hat{\sigma}}{3} = \text{\#VALUE!} \quad d = 0.2 \quad \frac{3\hat{\sigma}}{2} = \text{\#VALUE!}$$

Oxygen Index[Concentration (%)]:

D. Uncertainty estimation

$$\sigma_{OI} = \sqrt{\left( \frac{0.5}{\sqrt{3}} \right)^2 + \left( \frac{\hat{\sigma}}{\sqrt{6}} \right)^2} = \text{\#VALUE!}$$
$$\Delta OI = \sqrt{3} \times \sigma_{OI} = \text{\#VALUE!}$$

E. Observation

Performed by: Yutaro Kurosaki

2024-10-23 yk

## APPENDIX

### Determination of burning behavior by oxygen index

Reference standards:

- ☒ ISO 4589-2
- ☐ JIS K7201-2
- ☐ ASTM D2863

#### 1. Sample size

Table 1 – Test specimen dimensions

Test specimen form <sup>a</sup>	Dimensions			Typical use
	Length mm	Width mm	Thickness mm	
I	80 to 150	10 ± 0,5	4 ± 0,25	For moulding materials
II	80 to 150	10 ± 0,5	10 ± 0,5	For cellular materials
III <sup>b</sup>	80 to 150	10 ± 0,5	≤ 10,5	For sheet materials "as received"
IV	70 to 150	6,5 ± 0,5	3 ± 0,25	Alternative size for self-supporting moulding or sheet materials, for electrical purposes
V <sup>b</sup>	140 <sup>0</sup> <sub>-5</sub>	52 ± 0,5	≤ 10,5	For flexible film or sheet
VI <sup>c</sup>	140 to 200	20	0,02 to 0,10 <sup>d</sup>	For thin film "as received"; limited to the film that can be rolled by the specified rod <sup>d</sup>

<sup>a</sup> Test specimens of forms I, II, III and IV are suitable for materials that are self-supporting at these dimensions. Test specimens of form V are suitable for materials that require support during testing.

<sup>b</sup> Results obtained using form III or form V test specimens are likely to only be comparable for specimens of the same form and thickness. It is assumed that the amount of variation in thickness for such materials will be controlled by other standards.

<sup>c</sup> The test specimen of form VI is suitable for a thin film that is self-supporting when it is rolled. Dimensions in the table are of an original film from which the rolled form is made. See 7.2 for the preparation of rolled film.

<sup>d</sup> The film is limited to thicknesses that can be rolled by the specified rod (see Figure 7). If the film is very thin, it will potentially be necessary to combine two or more films together in the preparation of the rolled film so as to obtain results similar to those normally obtained with specimen form VI.

#### 2. Conditioning

Unless otherwise specified in other established standards, each test specimen shall be conditioned for at least 88 h at 23°C±2°C and [50±5] % relative humidity.

#### 3. Igniting the test specimen

Select one of two alternative ignition procedures which are dependent upon the specimen form as follows;

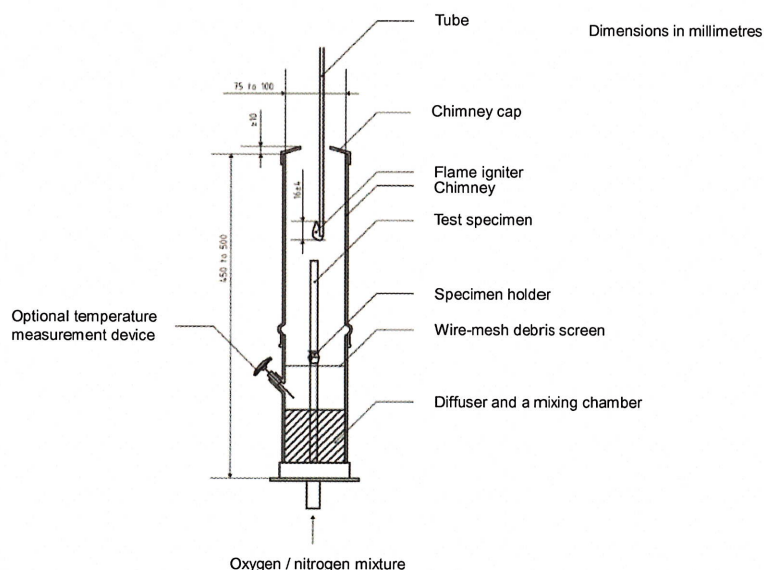


Figure 1 – Typical apparatus for determination of oxygen index



## (1) Procedure A – Top surface ignition (for specimens forms other than V)

The igniter is used to initiate burning only on the top surface of the upper end of the specimen. Apply the flame for up to 30 s, removing it every 5 s for just sufficient time to observe whether or not the entire top surface of the specimen is burning. Consider the specimen to be ignited, and commence measurement of the period and distance of burning, as soon as removal of the igniter, after a contact period increment of 5 s, reveals burning supported by the whole of the upper end of the specimen.

## (2) Procedure B – Propagating ignition (for specimen form V)

Lower and move the igniter sufficiently to apply the visible flame to the upper end face of the specimen and also, to a depth of approximately 6 mm, to its vertical faces. Continue to apply the igniter for up to 30 s, including interruptions for inspection of the specimen every 5 s, until its vertical faces are burning steadily or until the visibly burning portion first reaches the level of the upper reference mark on the support frame. Consider the specimen to be ignited, for the purpose of measuring the period and extent of burning, as soon as any part of the visible burning portion reaches the level of the upper reference mark.

If neither the period nor the extent of burning exceeds the relevant limit specified in the following Table 2 for the applicable specimen, record the result as an "O" response. If either the period or extent of burning exceeds the relevant limit, record the result as an "X" response.

**Table 2 – Criteria for oxygen index measurements**

Test specimen form	Ignition procedure	Alternative criteria	
		Period of burning after ignition (s)	Extent of burning
I, II, III, IV and VI	A Top surface ignition	180	50mm below the top of the specimen
V	B Propagating ignition	180	80mm below the upper reference mark (on the frame)

Repeat the procedures, until the volume fractions of oxygen have been found that they differ by  $\leq 1.0\%$  and of which one gave an "O" response and the other an "X" response. From this pair of volume fractions of oxygen, note the one which gave the "O" response as the preliminary volume fraction of oxygen level.

Using, again, the preliminary volume fraction of oxygen, test one specimen, and record the response "X" or "O". Change the volume fraction of oxygen, using the volume fraction changes of 0.2% to test further specimens, and record the corresponding responses until a different response is exhibited. These responses constitute the  $N_L$  series of results.

Test four more specimens, maintaining  $d = 0.2\%$ ; and note the volume fraction of oxygen used, and response of each specimen. Designate the volume fraction of oxygen used for the last specimen as  $c_f$ .

Calculate the OI from the relationship:

$$OI = c_f + (k \times d)$$

where

- $c_f$  is the final value of the volume fraction of oxygen, reported to three decimal places used in the series of NT measurements.
- $d$  is the interval between oxygen volume fraction levels used in the series of NT.
- $k$  is a factor to be obtained from the following Table 3.

**Table 3 – Values of k for calculating the oxygen index concentration from determinations made by Dixon's "up-and-down" method**

Responses for the last 5 measurements	Values of k for which the first $N_L$ determination are			
	O	OO	OOO	OOOO
O x x x (x O O O O)	-0.55	-0.55	-0.55	-0.55
O x x x O (x O O O x)	-1.25	-1.25	-1.25	-1.25
O x x O x (x O O x O)	0.37	0.38	0.38	0.38
O x x O O (x O O x x)	-0.17	-0.14	-0.14	-0.14
O x O x x (x O x O O)	0.02	0.04	0.04	0.04
O x O x O (x O x O x)	-0.50	-0.46	-0.45	-0.45
O x O O x (x O x x O)	1.17	1.24	1.25	1.25
O x O O O (x O x x x)	0.61	0.73	0.76	0.76
O O x x x (x x O O O)	-0.30	-0.27	-0.26	-0.26
O O x x O (x x O O x)	-0.83	-0.76	-0.75	-0.75
O O x O x (x x O x O)	0.83	0.94	0.95	0.95
O O x O O (x x O x x)	0.30	0.46	0.50	0.50
O O O x x (x x x O O)	0.50	0.65	0.68	0.68
O O O x O (x x x O x)	-0.04	0.19	0.24	0.25
O O O O x (x x x x O)	1.60	1.92	2.00	2.01
O O O O O (x x x x x)	0.89	1.33	1.47	1.50
	Values of k for which the first $N_L$ determination are x   x x   x x x   x x x x are as given in the above table opposite the appropriate response in O, but with the sign of k reversed, i.e. $OI = c_f - kd$			