

The test was performed per: Safe-T-Nose Letter of 05 September 2017

DIVISION OF ELECTRICAL AND ELECTRONIC MEASUREMENTS

TEST REPORT: NO. 1871190511 of 11 SEPTEMBER 2017

LUMINANCE AND SCOTOPIC VISIBILITY TEST

Material Tested: Photoluminescent layer on a flexible plastic substrate

Test Conditions:

1. The test was performed in a windowless laboratory room by the contact method (similar to ASTM 2073-10, para. 5.2 and 8.1 to 8.4). The sample scotopic visibility was observed by performing the test in the dark room using observation of the test sample by two laboratory workers whose vision was accommodated to the darkness.
2. Test sample activation: 10.76 lx (1.000 fc) for 60.0 min.
3. Excitation System:
 - 3.1. The excitation light source: 40 W Lamp of the 395 nm - 690 nm spectrum Model N6AFJEE0109, Color temperature $T_c=4400$ K. The tube holding fixture is equipped with two sliding black screens that control the part of the tube length, the light from which is directed toward the sample under test. The fixture is connected to the lamp pedestal with a system of fixable levers that allows the motion of the light tube holder parallel to itself in the vertical direction to vary the distance between the sample surface and the tube plane from 160 mm to 1,000 mm.
 - 3.2. The excitation system was covered with a pressboard box of the dimensions (mm) of 180×180×1,100 with a vertical slit along one side that allowed the motion of the fixable levers to vary the distance between the light source and the sample surface. In our experiments, the angle of vision of the sample from the light source location was close to 5.7°; with the open light source dimensions close to 25 mm by 25 mm, the theoretical uniformity of the illuminance of the entire sample surface was achieved, which was confirmed by the illuminance measurements.
4. The test consisted of three excitation/luminance measurement cycles with deactivation of the sample between the cycles for 30 min at 60°C. The luminance data in the table below are the average from the three cycle results.
5. The residual luminance of the sample before the test was removed by keeping it in the dark container at 60°C for 7.0 hours. The luminance of the sample measured prior to the test cycle was on the level of the luminance meter zero noise.

LUMINANCE TEST RESULTS

Test run No.	Post-excitation time hour	Luminance mcd/m ²	Sample scotopic visibility*	Test run No.	Post-excitation time hour	Luminance mcd/m ²	Sample scotopic visibility	Test run No.	Post-excitation time hour	Luminance mcd/m ²	Sample scotopic visibility
1	0.17	38.9	+	11	7.00	0.92	+	21	17.00	0.34	+
2	0.50	18.1	+	12	8.00	0.70	+	22	18.00	0.33	+
3	1.00	9.90	+	13	9.00	0.57	+	23	19.00	0.33	+
4	1.50	7.31	+	14	10.00	0.46	+	24	20.00	0.32	+
5	2.00	4.57	+	15	11.00	0.43	+	25	21.00	0.31	+
6	2.50	3.55	+	16	12.00	0.41	+	26	22.00	0.30	+
7	3.00	2.90	+	17	13.00	0.39	+	27	23.00	0.30	+
8	4.00	1.99	+	18	14.00	0.38	+	28	24.00	0.29	+
9	5.00	1.50	+	19	15.00	0.36	+				
10	6.00	1.12	+	20	16.00	0.35	+				

* Sign + means that the sample is visible by the adapted naked eye at the scotopic conditions.

TEST DESCRIPTION

1. The test per ASTM E2072-14 and ASTM E2073. Test conditions: T = 22°C, RH = 36%, P = 101.5 kPa. The scotopic visibility of the sample was performed by the naked eye observation in the direction normal to the sample plane from the distance of 2.0 m with a special attention to the eye accommodation to the darkness of the room.
2. After the excitation period, the samples were removed from the excitation chamber (in the darkened room) and put on the laboratory table; the luminance detector was installed upon the sample center, and the luminance test chamber of the inner dimensions (mm) of 258×208×164 and the wall/top thickness of 12 mm was used to cover the sample/detector pair to prevent any uncontrolled irradiation of the sample.
3. The experimental error, evaluated on the basis of the data related to the excitation process and the results of the luminance measurements on a standard reference material by the partial derivatives and least squares methods, does not exceed 6%. The data on the standard deviation are kept on file at CIEMS. To concentrate the numerical information for statistical considerations, a set of the luminance measurements on the sample tested was performed at the end of ten-minute intervals from 10 min to 100 min from the moment of the illumination process completion.
4. INSTRUMENTS AND DEVICES USED
 - Advanced Light Meter Model 84002 with Photosensor Q130110 Sper Sci. (10 mlx to 0.4 Glx) - excitation
 - Optometer Model X11 with Detector PD-9310B Gigahertz.-Optik (10 $\mu\text{cd}/\text{m}^2$ to 5 kcd/m^2) - luminance test
 - Radiation Pyrometer Model ST-30 Raynger - luminance reference calibration
 - Color Meter Model C-500 Prodigy Color Seconic - color temperature
 - Goniometer Model 3501-08 FD - angle measurements
 - 50 A, 6 V Stabilized Power Supply Model SC506FAVD HBC
 - Digital Timer Model Labchron-1402 Lab-Line Instr.
 - Starrett Dial Indicator Model 25-109 (1.270 $\mu\text{m}/\text{div}$)
 - Digital Hygrothermometer Model 63-844 MI, Barometer Model 602650 SB.
5. The standard reference materials and devices used for the test setup calibration:
 - Absolute Black-Body Radiator Model 9291L HMI with Platinum Wire Radiator - luminance measurements
 - Standard Candle with Optical Bench Model 47496 Sci. Kit & Boreal Labs. - illuminance.
6. The equipment used in the test meets the applicable NIST, ASTM, ASME, OSHA and State requirements and was calibrated with the standards traceable to the NIST. The calibration was performed per ANSI/ASQC M1-1996, ANSI/ISO/ASQ Q9004-2000, ISO 10012:2003, ISO 5725-2:1994, MIL-STD-45662, MIL-I-45208, NAVAIR-17-35-MTL-1, CSP-1/03-93, and the instruments manufacturers' specifications.
7. The equipment passed a periodic accuracy test in June 2017. Next test - June 2018. The linear and angular measure equipment and weights will pass the next semiannual calibration in December 2017.

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