TECHNICAL REPORT 8125

Published 1984-02-01

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Anodizing of aluminium and its alloys — Determination of colour and colour difference of coloured anodic coatings

Anodisation de l'aluminium et de ses alliages — Détermination de la couleur et de la différence de couleur des couches anodiques colorées

Technical Report 8125 was drawn up by Technical Committee ISO/TC 79, *Light metals and their alloys*. The reasons which led to the publication of the document as a Technical Report are explained in the Introduction.

0 Introduction

The characteristics of surface reflection on coloured anodic oxidation coatings on aluminium and its alloys (hereafter called colour-anodized aluminium) is different from that of normal reflection on other objects, such as opaque paint.

The colour of colour-anodized aluminium is perceived differently from that of common objects, which creates confusion when determining the colour and colour difference of colour-anodized aluminium.

This is due to the fact that the colour of colour-anodized aluminium possesses the property of metamerism : i.e., two colours which appear identical when viewed at one angle or when observed under one light source, no longer match if the viewing angle or the light source is changed (see the note). For example, the colour of an exterior wall of a building coated with colour-anodized aluminium, e.g. a curtain wall, could appear different to any observer in a different environment, weather conditions, time and under a different viewing angle. Some experiments show that near-transparent colour-anodized aluminium presents, at a varied incident angle, a different change in gloss and hue from that of the surface of opaque coatings.

NOTE — Refer to *Geometric Metamerism*, by Ruth M. Johnston, **42**/*Color engineering*, May-June 1967, and *Metamerism — A study in dimension*, **38**/*Color engineering*, Nov.-Dec. 1968.

At present, many methods are employed for determining colour and colour difference. These methods fall into one of two categories : visual methods and instrumental methods. For the determination of colour, Munsell Colour Chips have long been used for colour matching of common objects, such as paints, by the visual method and are still being used for this purpose. However, this method for specifying colour by Munsell notation is qualitative, so it is not possible to correlate its specified value with the instrumentally determined value directly.

The visual method, which can specify colour in numerical units using the Munsell Colour Chips, has been developed recently, and it is possible to correlate this new technique with the instrumental method, particularly for specifying the colour of colour-anodized aluminium. However, this method is not yet in widespread use.

For the determination of colour difference, the only visual method available at present seems to be the method using the grey scale for assessing change in colour, which can be correlated with the instrumental method. However, as the grey scale is neutral, care must be taken when it is applied to the evaluation of test specimens which differ in hue and saturation.

From these points of view, it has been deemed preferable to publish, in the form of an ISO Technical Report, a new technique for specifying colour and colour difference which permits good correlation between visual and instrumental methods.

UDC 669.716.9 : 535.65 **Ref. No. ISO/TR 8125-1984 (E)**

Descriptors : aluminium, aluminium alloys, anodizing, anodic coating, determination, colour, colour differences.

Printed in Switzerland

Preisgr. R

Price based on 33 pages

Initially, it was necessary to identify the insufficiencies in the correlation between the visual and instrumental methods. Table 1 shows the contrast between the visual and instrumental methods. The technical terms are defined in the body of this Technical Report. It should be noted, however, that special subscripts marked v in table 1, such as $L^*_v\ a^*_v\ b^*_v$, are used to indicate that the colours of samples are first determined in Munsell notation visually and then converted into values on the CIE 1976 ($L^*a^*b^*$) colour scale system to obtain the relationship between visual and instrumental values.

The $L^*a^*b^*$ system described in section two was adopted since it is the most representative of those recommended by CIE in 1976.

Table 1 — Current and newly proposed visual and instrumental methods for specifying colour and colour difference

	Current method		Newly proposed method	
	Visual	**Instrumental**	**Visual**	**Instrumental**
Colour	Munsell system	(1) xyY system (2) CIE 1976 ($L^*a^*b^*$) colour scale system (3) CIE 1976 ($L^*u^*v^*$) colour scale system (4) Adam's system	$L^*_v a^*_v b^*_v$ system (specifying in $L^*a^*b^*$ using Munsell colour chips)	CIE 1976 ($L^*a^*b^*$) colour scale system
Colour difference	Grey scale method	(1) CIE 1976 ($L^*a^*b^*$) colour difference (2) CIE 1976 ($L^*u^*v^*$) colour difference (3) Adam's system colour difference	Grey scale method with the data of $L^*a^*b^*$ colour difference	$L^*a^*b^*$ colour difference

This technical report includes the following sections and annexes :

- Section one : Visual method
- Section two : Instrumental method
- Section three : Relation between instrumental and visual methods
- Annex A : Methods other than those described in sections one and two
- Annex B : Instruments applicable to the methods described in annex A.

Section one : Visual method

1.1 Scope and field of application

This section describes the visual method for determination of the colour and the colour difference of colour-anodized aluminium surfaces.

1.2 Principle

1.2.1 The colour of a test specimen is determined in terms of specifically defined $L_v^* a_v^* b_v^*$ values by comparing it with Munsell colour chips under a perfectly diffuse light (standard illuminant D 65), assigning Munsell notation to it and then converting it using specific conversion charts.

1.2.2 The colour difference between a test specimen and a reference specimen is determined in grey scale grade by comparing the contrast between them with ISO grey scale for assessing change in colour under a perfectly diffuse light and assigning the grade to the test specimen.

1.3 Definition and description of terms

The terms and symbols used in this method are in accordance with those recommended by CIE, except the following :

1.3.1 Munsell notation

The symbol for hue, value and chroma are expressed in the colour space by the Munsell colour system. The symbol for hue is written first, and is followed by a symbol written in fraction form, the numerator indicating the value and the denominator indicating the chroma (HV/C).

1.3.2 CIE 1976 ($L^*a^*b^*$) space

The daylight colours of opaque specimens are represented by points in a space formed by three mutually perpendicular vectors having lightness scale L^* and chromaticity scales a^* and b^*.

These scales provide colour difference values that correlate with visually perceived colour differences.

1.3.3 CIE 1976 ($L^*a^*b^*$) colour scale

The L^*, a^* and b^* colour scales are defined in terms of the tristimulus values : X, Y and Z, as follows :

$$L^* = 116\ (Y/Y_n)^{1/3} - 16 \qquad X/X_n,\ Y/Y_n,\ Z/Z_n > 0{,}01$$

$$a^* = 500\ [(X/X_n)^{1/3} - (Y/Y_n)^{1/3}]$$

$$b^* = 200\ [(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}]$$

where X_n, Y_n and Z_n are the tristimulus values of perfect reflecting diffuser under CIE standard source employed in the observation.

1.3.4 $L_v^* a_v^* b_v^*$ colour scale

The L_v^*, a_v^* and b_v^* colour scales are defined as the colour scales which are converted from Munsell notation by the procedure specified in this method, to correspond to CIE 1976 ($L^*a^*b^*$) colour scales.

1.3.5 Grey scale grade

The grey scale grade is defined as the number for the grade of grey scale for assessing change in colour that corresponds to the difference in colour between two colours.

1.4 Apparatus

1.4.1 Standard illuminant apparatus

The apparatus shall have the light source yielding the spectral distribution similar to that of the standard light source D 65 specified by CIE shall be so designed to secure the perfectly diffuse light. (See figure 1.)

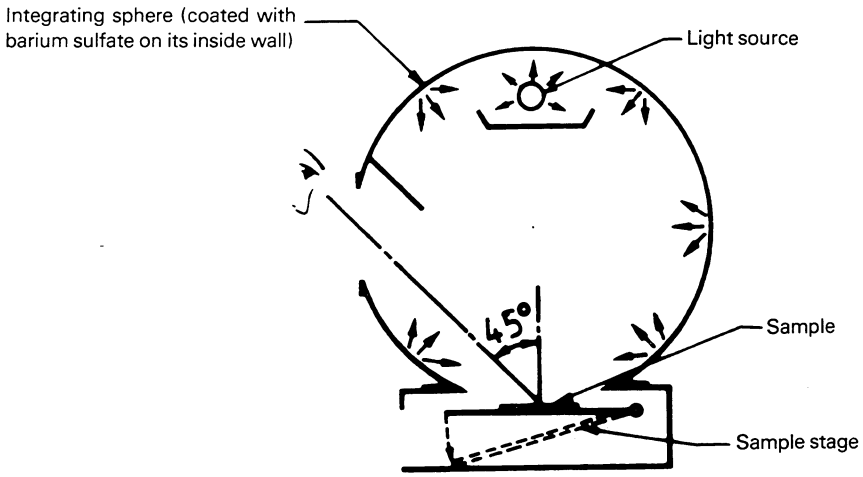

Figure 1 — Standard illumination apparatus

1.4.2 Munsell colour chips

The colour chips shall consist of glossy coloured chips based on the revised Munsell colour system. These are available from the following :

Munsell Color Company
2441 N. Calvert St.
BALTIMORE
Maryland 21218
USA

Japanese Standards Association
1-24 Akasaka 4
Minato-ku
TOKYO
Japan

1.4.3 Grey scale for assessing change in colour

The scale, which consists of nine grades, specified by ISO 105-A02, shall be used. The relation between each grade and its colour difference is as follows :

Grade	Colour difference, ΔE^*_{ab} (see the note)
5	0
4-5	0,9
4	1,7
3-4	2,6
3	3,4
2-3	4,8
2	6,8
1-2	9,6
1	13,5

NOTE — The colour differences were calculated in the $L^*a^*b^*$ system to correlate with the instrumental method. Data were obtained using CIE 1931 standard colorimetric system (2° observer data) for illuminant C which is the same as that for the instrumental method.

The scale is available from the following :

British Standards Institution
3 York Street,
MANCHESTER M2 2AT
United Kingdom

The Society of Dyers and Colourists
PO Box 244, Perkin House
82 Gratton Road
BRADFORD BD1 2JB
West Yorkshire
United Kingdom

Eidgenössische Materialprüfungs- und Versuchsanstalt
Unterstrasse 11
CH-9000 ST. GALLEN
Switzerland

Japanese Standards Association
1-24 Akasaka 4
Minato-ku
TOKYO
Japan

Beuth-Vertrieb GmbH
Burggrafenstrasse 47
D-1000 BERLIN 30
Germany

American Association of Textile Chemists and Colorists
PO Box 12215
RESEARCH TRIANGLE PARK
North Carolina 27709
USA

Association pour la détermination de la solidité
des teintures et impressions sur textiles
12 rue d'Anjou
F-75008 PARIS
France

1.4.4 Background

Grey mat paper with Munsell value 6 to 7 shall be used for the background on which the sample will be placed.

1.5 Test specimens

These test methods do not cover preparation techniques. Whenever a test for colour and colour difference requires the preparation of a specimen, the users of this method shall agree in advance on the technique of preparation.

1.6 Procedure

1.6.1 Illumination source

Natural daylight, or the apparatus which is described in 1.4.1 shall be used as an illumination source.

If natural daylight is used, it is recommended that the estimation shall be carried out during the 3 h after sunrise and the 3 h before sunset in fair weather.

1.6.2 Condition of illumination and observation

a) In case of natural daylight : The sample shall be placed horizontally on the grey mat paper in a location where the diffused light can be obtained, preventing direct sunlight and reflection from the surroundings, and shall be viewed at an angle of 45° to the vertical.

b) In case of artificial light : The sample shall be placed horizontally on the grey mat paper under the illumination of the standard illumination apparatus and shall be viewed at an angle of 45° to the vertical.

1.6.3 Determination of colour

1.6.3.1 Obtaining Munsell hue, value and chroma

Place a test specimen and the Munsell colour chips side by side in the same plane under a specified illumination source, and select the colour chip which is the nearest to the sample in hue, lightness and saturation to obtain the Munsell notation of the test specimen.

1.6.3.2 Specifying colour scales

Obtain the L^*, a^* and b^* values from the determined Munsell hue, value and chroma using table 2 and figure 2 to 10[1)], and specify each of them in terms of L^*_V, a^*_V and b^*_V respectively.

1.6.4 Determination of colour difference

Place the grey scale for assessing change in colour side by side with a test specimen and the reference specimen in edge contact under perfect diffused light, compare the contrast between the colours of two specimens with the grey scale and determine the grade by the grey scale.

NOTE — Care must be taken when applying the grey scale for assessing change in colour to the assessment of the colour difference of chromatic samples, because the grey scale consists essentially of achromatic chips.

1) Figures 2 to 10, which were prepared on the basis of 1976 CIE Recommendation on uniform colour spaces, colour difference equations and metric colour terms, were quoted from the *Colour Guide of Suga Weathering Technology Foundation*, 4-14 Shinjuku 5-chome Shinjuku-ku, TOKYO, Japan.

1.7 Report

The report shall include the following information :

a) for the colour determination : the L^*_V, a^*_V and b^*_V values of the test specimen.

In the case of specifying colour when the corresponding Munsell chip might not be found since the hue of the specimen is very high, the hue, the value and the chroma may be determined according to the presumption. In this case the reporting values of $L^*_V a^*_V b^*_V$ shall be noted as "the presumption values" and its reason shall also be noted;

b) for the colour difference determination : the grey scale grade of the test specimen;

c) the type of the light source and the apparatus used for the estimation, and the manufactuer's name;

d) the lightness of the light source, in lux.

Table 2 — Relation between Munsell value V and L^* scale

V	L^*	V	L^*	V	L^*	V	L^*
10,00	100,98						
9,99	100,88	9,54	96,40	9,09	91,96	8,64	87,57
9,98	100,78	9,53	96,30	9,08	91,86	8,63	87,47
9,97	100,68	9,52	96,20	9,07	91,77	8,62	87,37
9,96	100,58	9,51	96,10	9,06	91,67	8,61	87,28
9,95	100,48	9,50	96,00	9,05	91,57	8,60	87,18
9,94	100,38	9,49	95,90	9,04	91,47	8,59	87,08
9,93	100,28	9,48	95,80	9,03	91,37	8,58	86,98
9,92	100,18	9,47	95,71	9,02	91,28	8,57	86,89
9,91	100,08	9,46	95,61	9,01	91,18	8,56	86,79
9,90	99,98	9,45	95,51	9,00	91,08	8,55	86,69
9,89	99,88	9,44	95,41	8,99	90,98	8,54	86,59
9,88	99,78	9,43	95,31	8,98	90,88	8,53	86,50
9,87	99,68	9,42	95,21	8,97	90,79	8,52	86,40
9,86	99,58	9,41	95,11	8,96	90,69	8,51	86,30
9,85	99,48	9,40	95,01	8,95	90,59	8,50	86,21
9,84	99,38	9,39	94,91	8,94	90,50	8,49	86,11
9,83	99,28	9,38	94,81	8,93	90,40	8,48	86,01
9,82	99,18	9,37	94,72	8,92	90,30	8,47	85,91
9,81	99,08	9,36	94,62	8,91	90,20	8,46	85,82
9,80	98,98	9,35	94,52	8,90	90,10	8,45	85,72
9,79	98,88	9,34	94,42	8,89	90,01	8,44	85,62
9,78	98,78	9,33	94,32	8,88	89,91	8,43	85,52
9,77	98,68	9,32	94,22	8,87	89,81	8,42	85,43
9,76	98,58	9,31	94,12	8,86	89,72	8,41	85,33
9,75	98,48	9,30	94,03	8,85	89,62	8,40	85,23
9,74	98,38	9,29	93,93	8,84	89,52	8,39	85,13
9,73	98,29	9,28	93,83	8,83	89,42	8,38	85,04
9,72	98,19	9,27	93,73	8,82	89,32	8,37	84,94
9,71	98,09	9,26	93,63	8,81	89,22	8,36	84,84
9,70	97,99	9,25	93,53	8,80	89,13	8,35	84,75
9,69	97,89	9,24	93,44	8,79	88,03	8,34	84,65
9,68	97,78	9,23	93,34	8,78	88,93	8,33	84,55
9,67	97,69	9,22	93,24	8,77	88,84	8,32	84,45
9,66	97,59	9,21	93,14	8,76	88,74	8,31	84,36
9,65	97,49	9,20	93,05	8,75	88,64	8,30	84,26
9,64	97,39	9,19	92,94	8,74	88,54	8,29	84,16
9,63	97,29	9,18	92,85	8,73	88,44	8,28	84,06
9,62	97,19	9,17	92,75	8,72	88,35	8,27	83,97
9,61	97,09	9,16	92,65	8,71	88,25	8,26	83,87
9,60	96,99	9,15	92,55	8,70	88,15	8,25	83,77
9,59	96,89	9,14	92,46	8,69	88,06	8,24	83,68
9,58	96,79	9,13	92,35	8,68	87,96	8,23	83,58
9,57	96,69	9,12	92,26	8,67	87,86	8,22	83,48
9,56	96,60	9,11	92,16	8,66	87,76	8,21	83,38
9,55	96,50	9,10	92,06	8,65	87,66	8,20	83,29

Table 2 (*continued*)

V	L^*	V	L^*	V	L^*	V	L^*
8,19	83,19	7,54	76,87	6,89	79,52	6,24	64,10
8,18	83,09	7,53	76,78	6,88	70,42	6,23	64,00
8,17	83,00	7,52	76,68	6,87	70,32	6,22	63,89
8,16	82,90	7,51	76,58	6,86	70,22	6,21	63,79
8,15	82,80	7,50	76,48	6,85	70,13	6,20	63,70
8,14	82,71	7,49	76,39	6,84	70,03	6,19	63,60
8,13	82,61	7,48	76,29	6,83	69,93	6,18	63,50
8,12	82,51	7,47	76,19	6,82	69,83	6,17	63,40
8,11	82,42	7,46	76,09	6,81	69,73	6,16	63,30
8,10	82,31	7,45	76,00	6,80	69,63	6,15	63,20
8,09	82,22	7,44	75,90	6,79	69,53	6,14	63,10
8,08	82,12	7,43	75,80	6,78	69,43	6,13	63,00
8,07	82,03	7,42	75,71	6,77	69,34	6,12	62,90
8,06	81,93	7,41	75,61	6,76	69,24	6,11	62,80
8,05	81,83	7,40	75,51	6,75	69,14	6,10	62,70
8,04	81,73	7,39	75,41	6,74	69,04	6,09	62,60
8,03	81,64	7,38	75,31	6,73	68,95	6,08	62,50
8,02	81,54	7,37	75,21	6,72	68,85	6,07	62,40
8,01	81,45	7,36	75,12	6,71	68,75	6,06	62,30
8,00	81,35	7,35	75,02	6,70	68,65	6,05	62,20
7,99	81,24	7,34	74,93	6,69	68,55	6,04	62,10
7,98	81,15	7,33	74,82	6,68	68,45	6,03	62,00
7,97	81,05	7,32	74,73	6,67	68,35	6,02	61,90
7,96	80,96	7,31	74,63	6,66	68,26	6,01	61,80
7,95	80,86	7,30	74,53	6,65	68,15	6,00	61,70
7,94	80,76	7,29	74,43	6,64	68,06	5,99	61,60
7,93	80,67	7,28	74,34	6,63	67,96	5,98	61,50
7,92	80,57	7,27	74,24	6,62	67,86	5,97	61,40
7,91	80,47	7,26	74,14	6,61	67,76	5,96	61,30
7,90	80,38	7,25	74,04	6,60	67,66	5,95	61,20
7,89	80,28	7,24	73,95	6,59	67,56	5,94	61,10
7,88	80,18	7,23	73,85	6,58	67,46	5,93	61,00
7,87	80,08	7,22	73,75	6,57	67,37	5,92	60,90
7,86	79,99	7,21	73,66	6,56	67,27	5,91	60,80
7,85	79,89	7,20	73,56	6,55	67,17	5,90	60,69
7,84	79,79	7,19	73,45	6,54	67,07	5,89	60,60
7,83	79,69	7,18	73,36	6,53	66,97	5,88	60,50
7,82	79,60	7,17	73,27	6,52	66,87	5,87	60,40
7,81	79,50	7,16	73,17	6,51	66,77	5,86	60,29
7,80	79,40	7,15	73,07	6,50	66,67	5,85	60,19
7,79	79,31	7,14	72,97	6,49	66,57	5,84	60,10
7,78	79,21	7,13	72,87	6,48	66,47	5,83	60,00
7,77	79,11	7,12	72,77	6,47	66,37	5,82	59,90
7,76	79,01	7,11	72,67	6,46	66,27	5,81	59,80
7,75	78,91	7,10	72,57	6,45	66,18	5,80	59,69
7,74	78,82	7,09	72,48	6,44	66,08	5,79	59,59
7,73	78,72	7,08	72,38	6,43	65,98	5,78	59,49
7,72	78,62	7,07	72,28	6,42	65,88	5,77	59,39
7,71	78,53	7,06	72,19	6,41	65,78	5,76	59,29
7,70	78,43	7,05	72,09	6,40	65,69	5,75	59,19
7,69	78,33	7,04	71,99	6,39	65,58	5,74	59,09
7,68	78,23	7,03	71,89	6,38	65,48	5,73	59,00
7,67	78,14	7,02	71,79	6,37	65,39	5,72	58,89
7,66	78,04	7,01	71,70	6,36	65,29	5,71	58,79
7,65	77,95	7,00	71,60	6,35	65,18	5,70	58,69
7,64	77,85	6,99	71,50	6,34	65,09	5,69	58,58
7,63	77,75	6,98	71,40	6,33	64,99	5,68	58,49
7,62	77,65	6,97	71,30	6,32	64,89	5,67	58,39
7,61	77,56	6,96	71,21	6,31	64,79	5,66	58,28
7,60	77,46	6,95	71,10	6,30	64,69	5,65	58,18
7,59	77,36	6,94	71,01	6,29	64,60	5,64	58,08
7,58	77,26	6,93	70,91	6,28	64,49	5,63	57,98
7,57	77,17	6,92	70,82	6,27	64,40	5,62	57,88
7,56	77,07	6,91	70,71	6,26	64,30	5,61	57,78
7,55	76,97	6,90	70,62	6,25	64,19	5,60	57,67

Table 2 (*continued*)

V	L^*	V	L^*	V	L^*	V	L^*
5,59	57,58	4,94	50,96	4,29	44,22	3,64	37,45
5,58	57,47	4,93	50,85	4,28	44,13	3,63	37,35
5,57	57,38	4,92	50,76	4,27	44,02	3,62	37,25
5,56	57,27	4,91	50,65	4,26	43,92	3,61	37,14
5,55	57,17	4,90	50,55	4,25	43,80	3,60	37,04
5,54	57,08	4,89	50,44	4,24	43,70	3,59	36,93
5,53	56,97	4,88	50,33	4,23	43,60	3,58	36,83
5,52	56,87	4,87	50,24	4,22	43,49	3,57	36,72
5,51	56,77	4,86	50,13	4,21	43,39	3,56	36,62
5,50	56,66	4,85	50,03	4,20	43,29	3,55	36,51
5,49	56,57	4,84	49,93	4,19	43,18	3,54	36,41
5,48	56,47	4,83	49,82	4,18	43,08	3,53	36,30
5,47	56,37	4,82	49,73	4,17	42,97	3,52	36,20
5,46	56,26	4,81	49,62	4,16	42,87	3,51	36,10
5,45	56,16	4,80	49,52	4,15	42,76	3,50	36,00
5,44	56,06	4,79	49,41	4,14	42,66	3,49	35,89
5,43	55,96	4,78	49,31	4,13	42,55	3,48	35,78
5,42	55,86	4,77	49,20	4,12	42,46	3,47	35,68
5,41	55,76	4,76	49,11	4,11	42,35	3,46	35,57
5,40	55,65	4,75	49,01	4,10	42,25	3,45	35,47
5,39	55,55	4,74	48,90	4,09	42,14	3,44	35,36
5,38	55,45	4,73	48,80	4,08	42,03	3,43	35,26
5,37	55,35	4,72	48,69	4,07	41,94	3,42	35,15
5,36	55,25	4,71	48,59	4,06	41,83	3,41	35,05
5,35	55,14	4,70	48,49	4,05	41,72	3,40	34,95
5,34	55,04	4,69	48,39	4,04	41,63	3,39	34,84
5,33	54,94	4,68	48,29	4,03	41,52	3,38	34,74
5,32	54,85	4,67	48,17	4,02	41,41	3,37	34,63
5,31	54,74	4,66	48,07	4,01	41,31	3,36	34,53
5,30	54,64	4,65	47,97	4,00	41,22	3,35	34,42
5,29	54,53	4,64	47,87	3,99	41,11	3,34	34,32
5,28	54,43	4,63	47,76	3,98	41,01	3,33	34,21
5,27	54,33	4,62	47,66	3,97	40,90	3,32	34,11
5,26	54,23	4,61	47,56	3,96	40,80	3,31	34,00
5,25	54,12	4,60	47,46	3,95	40,69	3,30	33,90
5,24	54,03	4,59	47,35	3,94	40,59	3,29	33,79
5,23	53,92	4,58	47,25	3,93	40,49	3,28	33,69
5,22	53,82	4,57	47,14	3,92	40,38	3,27	33,59
5,21	53,72	4,56	47,04	3,91	40,28	3,26	33,48
5,20	53,62	4,55	46,93	3,90	40,17	3,25	33,37
5,19	53,51	4,54	46,83	3,89	40,07	3,24	33,27
5,18	53,42	4,53	46,72	3,88	39,96	3,23	33,17
5,17	53,31	4,52	46,63	3,87	39,86	3,22	33,06
5,16	53,21	4,51	46,53	3,86	39,76	3,21	32,96
5,15	53,10	4,50	46,41	3,85	39,65	3,20	32,86
5,14	53,00	4,49	46,30	3,84	39,55	3,19	32,75
5,13	52,91	4,48	46,29	3,83	39,44	3,18	32,66
5,12	52,80	4,47	46,10	3,82	39,34	3,17	32,54
5,11	52,70	4,46	45,99	3,81	39,23	3,16	32,44
5,10	52,60	4,45	45,88	3,80	39,13	3,15	32,33
5,09	52,50	4,44	45,78	3,79	39,02	3,14	32,23
5,08	52,39	4,43	45,68	3,78	38,92	3,13	32,12
5,07	52,29	4,42	45,58	3,77	38,80	3,12	32,02
5,06	52,19	4,41	45,47	3,76	38,71	3,11	31,92
5,05	52,09	4,40	45,37	3,75	38,61	3,10	31,81
5,04	51,98	4,39	45,26	3,74	38,50	3,09	31,71
5,03	51,88	4,38	45,16	3,73	38,39	3,08	31,60
5,02	51,78	4,37	45,05	3,72	38,29	3,07	31,50
5,01	51,68	4,36	44,96	3,71	38,19	3,06	31,40
5,00	51,58	4,35	44,84	3,70	38,08	3,05	31,29
4,99	51,47	4,34	44,74	3,69	37,98	3,04	31,19
4,98	51,37	4,33	44,63	3,68	37,87	3,03	31,08
4,97	51,27	4,32	44,53	3,67	37,77	3,02	30,98
4,96	51,16	4,31	44,43	3,66	37,66	3,01	30,88
4,95	51,06	4,30	44,33	3,65	37,56	3,00	30,77

Table 2 (*continued*)

V	L^*	V	L^*	V	L^*	V	L^*
2,99	30,67	2,34	23,97	1,69	17,46	1,04	11,04
2,98	30,56	2,33	23,87	1,68	17,37	1,03	10,94
2,97	30,46	2,32	23,77	1,67	17,27	1,02	10,83
2,96	30,36	2,31	23,66	1,66	17,17	1,01	10,73
2,95	30,25	2,30	23,57	1,65	17,07	1,00	10,63
2,94	30,15	2,29	23,47	1,64	16,97	0,99	10,53
2,93	30,04	2,28	23,36	1,63	16,87	0,98	10,42
2,92	29,94	2,27	23,26	1,62	16,78	0,97	10,32
2,91	29,84	2,26	23,16	1,61	16,68	0,96	10,21
2,90	29,73	2,25	23,06	1,60	16,58	0,95	10,11
2,89	29,63	2,24	22,95	1,59	16,48	0,94	10,02
2,88	29,53	2,23	22,85	1,58	16,39	0,93	9,91
2,87	29,42	2,22	22,75	1,57	16,29	0,92	9,81
2,86	29,32	2,21	22,65	1,56	16,19	0,91	9,70
2,85	29,21	2,20	22,55	1,55	16,08	0,90	9,59
2,84	29,11	2,19	22,45	1,54	15,99	0,89	9,48
2,83	29,01	2,18	22,35	1,53	15,89	0,88	9,38
2,82	28,90	2,17	22,25	1,52	15,80	0,87	9,27
2,81	28,80	2,16	22,15	1,51	15,70	0,86	9,17
2,80	28,69	2,15	22,05	1,50	15,60	0,85	9,06
2,79	28,59	2,14	21,95	1,49	15,50	0,84	8,95
2,78	28,49	2,13	21,85	1,48	15,49	0,83	8,84
2,77	28,39	2,12	21,74	1,47	15,30	0,82	8,73
2,76	28,28	2,11	21,65	1,46	15,21	0,81	8,62
2,75	28,18	2,10	21,55	1,45	15,11	0,80	8,51
2,74	28,07	2,09	21,45	1,44	15,01	0,79	8,40
2,73	27,97	2,08	21,34	1,43	14,91	0,78	8,29
2,72	27,87	2,07	21,24	1,42	14,81	0,77	8,18
2,71	27,76	2,06	21,14	1,41	14,71	0,76	8,07
2,70	27,66	2,05	21,04	1,40	14,61	0,75	7,96
2,69	27,56	2,04	20,94	1,39	14,52	0,74	7,84
2,68	27,45	2,03	20,84	1,38	14,42	0,73	7,73
2,67	27,35	2,02	20,74	1,37	14,32	0,72	7,62
2,66	27,25	2,01	20,64	1,36	14,23	0,71	7,52
2,65	27,15	2,00	20,54	1,35	14,13	0,70	7,40
2,64	27,04	1,99	20,44	1,34	14,03	0,69	7,29
2,63	26,94	1,98	20,34	1,33	13,93	0,68	7,18
2,62	26,84	1,97	20,24	1,32	13,83	0,67	7,07
2,61	26,73	1,96	20,14	1,31	13,73	0,66	6,96
2,60	26,63	1,95	20,04	1,30	13,63	0,65	6,86
2,59	26,53	1,94	19,94	1,29	13,53	0,64	6,75
2,58	26,42	1,93	19,84	1,28	13,44	0,63	6,64
2,57	26,32	1,92	19,74	1,27	13,34	0,62	6,53
2,56	26,22	1,91	19,64	1,26	13,24	0,61	6,42
2,55	26,12	1,90	19,54	1,25	13,14	0,60	6,31
2,54	26,02	1,89	19,45	1,24	13,04	0,59	6,21
2,53	25,91	1,88	19,35	1,23	12,94	0,58	6,10
2,52	25,81	1,87	19,25	1,22	12,84	0,57	5,99
2,51	25,71	1,86	19,14	1,21	12,74	0,56	5,88
2,50	25,61	1,85	19,05	1,20	12,65	0,55	5,78
2,49	25,50	1,84	18,95	1,19	12,54	0,54	5,67
2,48	25,40	1,83	18,85	1,18	12,45	0,53	5,57
2,47	25,30	1,82	18,75	1,17	12,34	0,52	5,46
2,46	25,20	1,81	18,65	1,16	12,25	0,51	5,36
2,45	25,09	1,80	18,55	1,15	12,15	0,50	5,25
2,44	24,99	1,79	18,45	1,14	12,04	0,49	5,15
2,43	24,89	1,78	18,36	1,13	11,94	0,48	5,05
2,42	24,79	1,77	18,25	1,12	11,84	0,47	4,94
2,41	24,68	1,76	18,16	1,11	11,74	0,46	4,83
2,40	24,58	1,75	18,06	1,10	11,65	0,45	4,73
2,39	24,48	1,74	17,96	1,09	11,55	0,44	4,63
2,38	24,38	1,73	17,86	1,08	11,44	0,43	4,53
2,37	24,28	1,72	17,76	1,07	11,35	0,42	4,42
2,36	24,17	1,71	17,66	1,06	11,24	0,41	4,32
2,35	24,07	1,70	17,56	1,05	11,14	0,40	4,22

Table 2 (*concluded*)

V	L^*	V	L^*	V	L^*	V	L^*
0,39	4,11	0,29	3,08	0,19	2,03	0,09	0,96
0,38	4,02	0,28	2,97	0,18	1,93	0,08	0,87
0,37	3,90	0,27	2,87	0,17	1,82	0,07	0,76
0,36	3,80	0,26	2,76	0,16	1,73	0,06	0,66
0,35	3,69	0,25	2,66	0,15	1,62	0,05	0,55
0,34	3,60	0,24	2,56	0,14	1,51	0,04	0,44
0,33	3,49	0,23	2,46	0,13	1,40	0,03	0,33
0,32	3,39	0,22	2,35	0,12	1,29	0,02	0,22
0,31	3,28	0,21	2,24	0,11	1,18	0,01	0,11
0,30	3,18	0,20	2,14	0,10	1,08	0,00	0,00

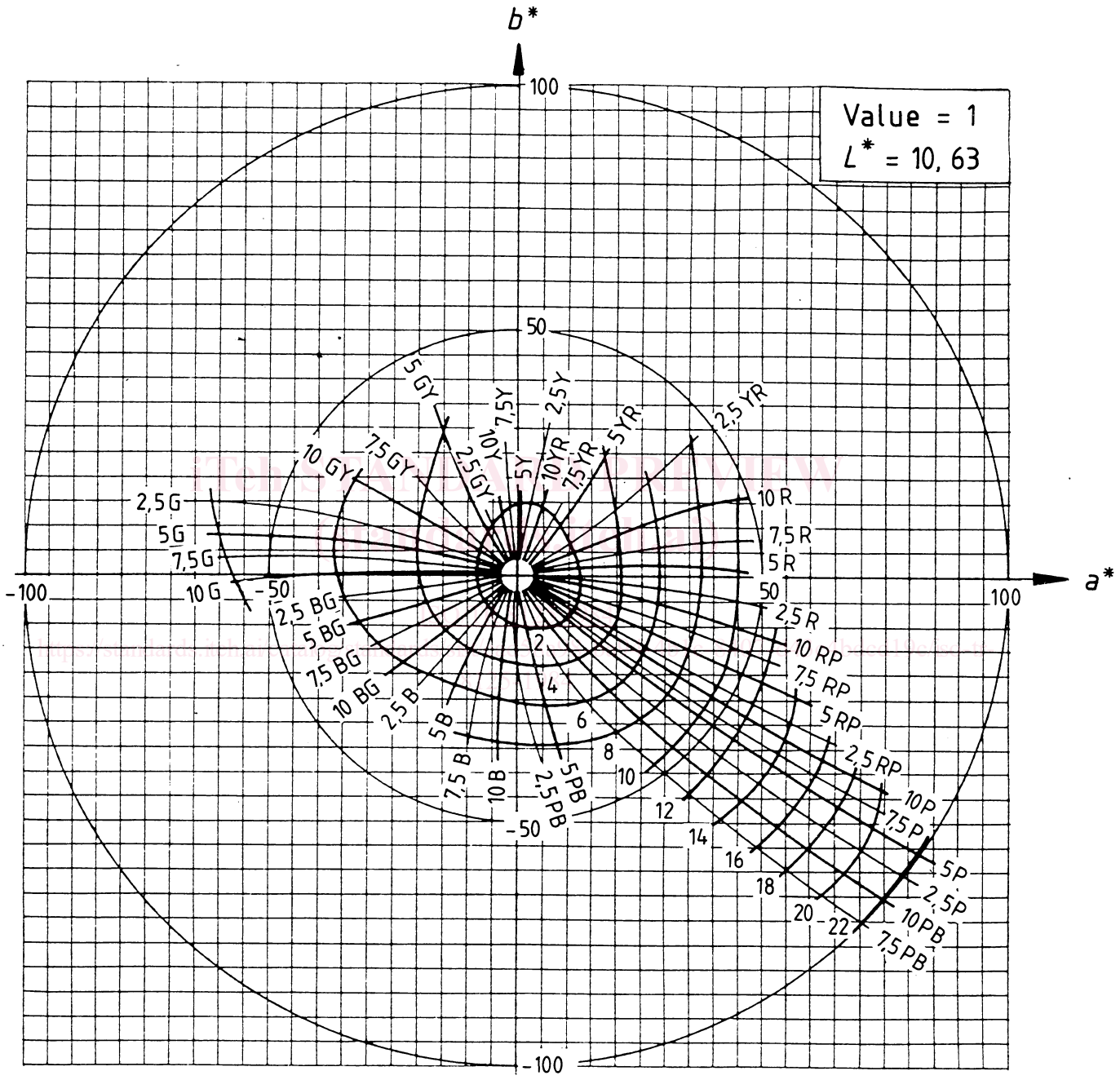

Figure 2 — Conversion chart from Munsell hue, value and chroma to a^* and b^* — Munsell value 1

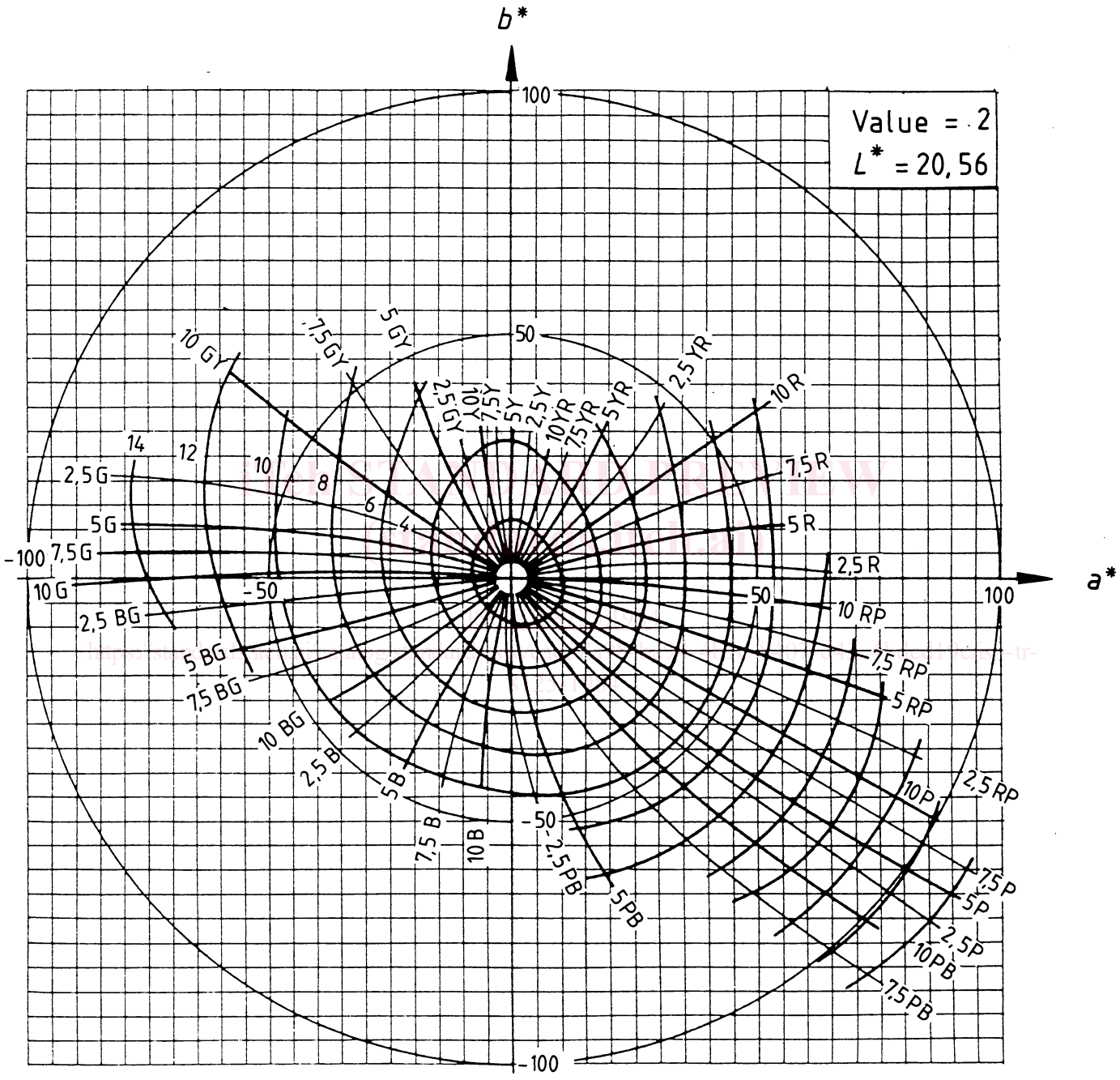

Figure 3 — Conversion chart from Munsell hue, value and chroma to a^* and b^* — Munsell value 2