

**INVOICE FOR ISSUE OF
TOYOTA ENGINEERING STANDARD**

NO. : TSH6504G

TITLE : ELECTROPLATED CHROMIUM COATINGS FOR DECORATION

CLASS : C2

PUBLICATION RECORD

This standard has been revised in consequence of the following changes:
(1) a copper coating thickness on plastic has been clearly specified; and
(2) a statement has been added that conformance to prohibitions and restrictions for substances of environmental concern in TSE0001G is required.

Steve

We are quoting
to TSH6504G-13

EXCEPT

12 microns nickel
of microns
crack free chrome

Patrick
Oct 2, 2006

Engineering Information
Planning Dept.
Engineering Administration Div.
TOYOTA MOTOR CORPORATION

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	TOYOTA ENGINEERING STANDARD	TSH6504G	CLASS
			C2

ELECTROPLATED CHROMIUM COATINGS FOR DECORATION**1. Scope**

This standard covers copper-nickel-chromium, nickel-chromium and chromium coatings (hereinafter referred to as "coating") to be deposited on automotive parts for the purposes of decoration and corrosion prevention. The parts made of materials provided by this standard shall conform to prohibitions and restrictions for substances of environmental concern in TSE0001G. Exempt uses specified by EU ELV Directive shall conform to the latest version of the Directive.

2. Summary of Treatments

After applying pretreatments suited to the kinds of base material and the surface conditions (such as degreasing, cleaning, derusting, activation, etching, increasing electric conductivity, etc.), copper, nickel and chromium coating shall be electroplated.

3. Classification

The coating shall be classified into the 4 grades given in Table 1 according to the service conditions.

Table 1

Grade	Code	Service condition	Application
U	TSH6504G-U	Very severe	Exterior parts
S	TSH6504G-S	Severe	
A	TSH6504G-A	Moderate	
B	TSH6504G-B	Mild	Interior parts

4. Quality**4.1 Appearance**

The surface of coating shall be tested according to the testing method in Section 6.1. The surface should be smooth and flat, has gloss, and be free of stain, blister, flaw, crack, uncoated area, pit, rough deposit and other abnormalities⁽¹⁾. However, these quality requirements are not applicable to invisible areas of the completely built-up motor vehicles.

Note: (1)

The permissible limit shall be predetermined between the parties concerned by using limit samples. The limit is as far as being invisible when inspected visually from the distance of 50 cm under daylight in the condition of completely built-up vehicle.

Prepared and Written by:

Paint & Finishing Design Dept.

Material Engineering Div.1

Engineering Administration Div.

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4.2 Coating Thickness and Corrosion Resistance

The coating thickness and corrosion resistance shall be tested according to the testing method specified in Sections 6.2 to 6.5 and shall meet the requirements in Table 2. However, the application range shall be determined by the agreement between the parties concerned.

Table 2

Grade	Code	Kind of base material	Coating method ⁽²⁾	Minimum coating thickness ⁽¹⁾ (μm)			Corrosion resistance (h)		
				Copper ⁽¹⁾	Nickel	Chromium (Sec. 5.3)	SST ⁽²⁾	Corrodokote ⁽²⁾	CASS ⁽²⁾
0	TSH6504G-U	Zinc alloy	a or b	10	35	0.6	240 min.	48 min.	200 min.
			c	---					
		Plastic	---	---	---	---	---		
S	TSH6504G-S	Iron	d	---	25	0.7	200 min.	48 min.	60 min.
			b or c	10					
		Aluminum alloy	---	---	---	---	---		
		Zinc alloy	---	---	---	---	---		
		Plastic	---	---	---	---	---		
A	TSH6504G-A	Iron	d	---	15	0.6	72 min.	16 min.	30 min.
			b or c	---					
		Aluminum alloy	---	17	0.15	---	---		
		Zinc alloy	b	7.5	10	0.1	---	---	
		c	10	0.15	---	---			
		Plastic	b	---	0.1	---	---		
		c	---	0.15	---	---			
Stainless	---	---	0.1	---	---				
B	TSH6504G-B	Iron	---	7	5	---	24 min.	---	---
			---	---					
		Zinc alloy	---	---	---	---	---		
		Plastic	---	---	---	---	---		
		Aluminum alloy	---	7	8	---	32 min.	---	---
			---	---					

Note: (2)

The coating method shall conform to Table 3, provided that the method shall be selected from among the ranges designated to each kind of base material.

Table 3

Coating method	Nickel	Chromium
a	Double or triple	Crack-free + microcrack
b	Double or triple + high stress strike	Microcrack
c	Double or triple + dispersed strike	Microporous
d	Double or triple	Microcrack (thick deposit)

Remark:

As for double and triple nickel coatings, the thickness of semibright nickel layer should be no less than a half of the whole nickel layer thickness.

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TSH6504G

Note: (3)

The measuring point of coating thickness shall be set, as a rule, at the portion having minimum thickness. However, if the coating thickness is markedly uneven due to the shape, the measuring point may be changed according to the agreement between the parties concerned.

Note: (4)

The copper coating may be substituted for the nickel coating except the case that the base material is zinc alloy or aluminum alloy.

Note: (5)

Salt spray test: For Grade U, carry out this test after the gravel test specified in Method E in TSH1553G on the center portion of specimen cut to an appropriate size. No rusting shall be observed. For Grade S and Grade A, no rusting shall be observed after carrying out this test without the gravel test. For Grade B, carry out this test without the gravel test and there shall not be three or more rust spots in each applicable area of 100 cm².

Note: (6)

Corrodokote test: There shall not be any recognizable rust or discoloration by visual inspection from a distance of 50 cm. As for these coatings of grades other than U, there shall not be any spot of which local corrosion rate exceeds 10 %. If, however, applicable area is 25 cm² or less, overall corrosion rate shall not exceed 10 %.

Note: (7)

CASS test: There shall not be any recognizable rust (surface rust) or discoloration by visual inspection from a distance of 50 cm.

Note: (8)

Such coating thickness is required that guarantees the appearance and thermal cycle resistance. This shall be the same or more than the thickness of nickel coating at the measurement point subject to conditions of the base material such as shape, size and forming conditions.

4.3 Thermal Cycle Resistance

In case the base material is plastic, the formed coating must meet the requirements given in Table 4 in the thermal cycle resistance test carried out according to the test method in Section 6.6.

Table 4

Code	Thermal cycle test ⁽⁹⁾ (Cycle)
TSH6504G-U	4 min.
TSH6504G-S	
TSH6504G-A	
TSH6504G-B	2 min.

Note: (9)

Blisters, peeling or crack in the applicable surface must not occur.

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TSH6504G

4.4 Adhesion

The adhesion of coating must be tested by the test method in Section 6.7 and peeling must not easily occur between base material and coating layers.

4.4.1 Metal Base

Adhesion of coating onto the base metal shall be tested by the method specified in Section 6.7.1, and peeling must not occur between base material and coating layers.

4.4.2 Plastic Base

Adhesion of coating onto the base plastic shall be tested by the method specified in Section 6.7.2, and peeling must easily not occur between base material and coating layers. Criteria for evaluation of the test result vary depending on the test method and shall be determined upon agreement between the parties concerned.

4.5 Ductility

The ductility of bright nickel coating must be 0.1 or more when tested according to the test method in Section 6.8. The ductility of semibright nickel coating must be 0.4 or more when tested according to the test method in Section 6.8.

5. Process Conditions

The coating process shall satisfy the following conditions.

5.1 Double Nickel Coating

- (1) Double coating consisting of semibright nickel coating in the lower layer and bright nickel coating in the upper layer is applied.
- (2) The content ratio of sulfur must be 0 to 0.005 % for semibright nickel coating layer and 0.05 to 0.07 % for bright nickel coating layer.

5.2 Triple Nickel Coating

- (1) Between the semibright nickel coating layer and bright nickel coating layer, both similar to those in the case of double coating, the intermediate nickel coating exceeding 0.6 μm in thickness is applied.
- (2) The content ratio of sulfur in the intermediate nickel layer must be 0.1 % or more.

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TOYOTA ENGINEERING STANDARD

TSH6504G

5.3 Microcrack Chromium (Double Layered Chromium) Coating

- (1) The crack-free chromium layer prepared by a special bath composition shall be applied as the first layer. Then, the second chromium layer with many microcracks, which appeared through another special bath composition and thick deposit, shall be applied on the first layer.
- (2) The number of microcracks shall meet requirements given in Table 5. After washing the specimen with hot water (80 °C×3 min), electrolyze it in the condition shown below using a coulometric method. Then, count the microcracks using a microscope.
 - (a) Gasket to be used: S
 - (b) Electrolyzing speed: 0.01 μm/s
 - (c) Electrolytic film thickness: 0.2 μm
- (3) The thickness of each coating layer shall be 0.4 μm or more.

Table 5

Class	Cracks/cm
TSH6504G-U	300 to 800
TSH6504G-S	250 min.
TSH6504G-A	100 min.

5.4 Microcrack Chromium (Normal Chromium) Coating

- (1) Many microcracks shall appear on the surface by depositing the high-internal-stress nickel coating prepared by a special bath composition on the double or triple nickel coating to be 0.6 μm or more of thickness and further depositing the normal nickel coating on it.
- (2) The number of the microcracks shall meet requirements given in Table 5. Number of the microcracks shall be counted by the method specified in the Appendix 2 of JIS H 8617 or ASTM B456.

5.5 Microporous Chromium (Normal Chromium) Coating

- (1) A large quantity of pores shall appear on the chromium layer when nickel coating which has nonconductive particles as eutectoid in the layer under the chromium layer is applied.
- (2) The number of pores shall be 2000/cm² or more. Number of the microcracks shall be counted by the method specified in Section 6.9.

6. Test Methods

6.1 Visual Inspection

The test surface shall be visually inspected at a distance of 500 mm under a room light.

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TSH6504G

6.2 Thickness Test

The thickness shall be measured with a microscope, as a rule, or the coulometric method may be used as an alternative. For the measurement of chromium thickness only, the fluorescent X-ray thickness gage may be used.

6.3 Salt Spray Test

The test shall be continuously carried out according to JIS Z 2371 or ASTM B117.

6.4 Corrodokote Test

The test shall be carried out according to JIS H 8502 or ASTM B380.

6.5 CASS Test

The test shall be carried out according to JIS H 8502 or ASTM B368.

6.6 Thermal Cycle Test

The specimen which, as a rule, have passed 48 h after being coated, shall be tested up to the specified cycles, with each cycle satisfying the conditions given in Table 6.

Table 6

Sequence	Temperature (°C)		Time (min)
	For normal	For high temperature	
1	-30	-40	60
2	Room temperature (20±10)		15
3	70	90 or more ⁽¹⁰⁾	60
4	Room temperature (20±10)		15

Note: (10)

This value shall be determined by the agreement between the parties concerned.

6.7 Adhesion Test

6.7.1 Metallic Base Material

Any of the grinding wheel test method, bend test method or tensile test method specified in JIS K 8504 or ASTM B571 shall be employed.

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6.7.2 Plastic Base Material

The test method specified in Appendix 6 in JIS H 8630 or ASTM B533 shall be employed. The following method, however, may also be employed. As a rule, the adhesion test shall be carried out in the following procedures on the specimen having passed 48 h after being coated.

- (1) Cross cut the coating surface with a sharp knife in such a manner that the cut may reach the base material as illustrated in Fig. 1.
- (2) Raise the coated film at the acute angle portion from the cross point.
- (3) Pull the raised coated film in the direction vertical to the coating surface.

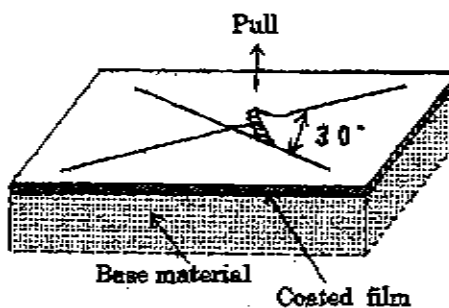


Fig. 1

Remark 1:

In case the base material is plastic, the adhesion strength of the coating is usually more than 9.8 N/cm when the test is carried out by pulling up a 10-mm wide strip of coating at the peeling speed of 30 mm/min.

Remark 2:

The measurement of the coating thickness should be assured in the strict meaning (ex. 3 σ method). Thus, generally, the average coating thickness at a measurement point (ex. center line of \bar{x} control chart) shall be 30 to 50 % more than the specified value.

6.8 Ductility Test

The test shall be carried out according to ASTM B490.

6.9 Measurement of Pores

- (1) Conduct the CASS test specified in Section 6.5 for the period of time specified in Table 2.
- (2) Clean off the surface with water.
- (3) Use an alkaline solution (ex. sodium carbonate 50 g/L) to peel away chrome using anodic electrolysis (6 to 8 V).
- (4) Measure the amount of pores by using a pair of 100-power binoculars.

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TSH6504G

Applicable Standards

TSH1553G	Test Method for Chip Resistance of Paint Films
TS20001G	Control Rules for Substances of Environmental Concern
JIS H 8502	Methods of Corrosion Resistance Test for Metallic Coatings
JIS H 8504	Methods of Adhesion Test for Metallic Coatings
JIS H 8617	Electroplated Coatings of Nickel and Chromium
JIS H 8630	Electroplated Coatings on Plastics Materials for Decorative Purposes
JIS Z 2371	Methods of Salt Spray Testing
ASTM B117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM B368	Method for Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS Test)
ASTM B380	Test Method of Corrosion Testing of Decorative Electrodeposited Coatings by the Corrodkote Procedure
ASTM B456	Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
ASTM B490	Practice for Micrometer Bend Test for Ductility of Electrodeposits
ASTM B533	Test Method for Peel Strength of Metal Electroplated Plastics
ASTM B571	Practice for Qualitative Adhesion Testing of Metallic Coatings

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