Quantifying Human Impressions of Glossy Plated Surfaces Using The Semantic Differential Technique

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Abstract:

Glossy Plating has already been used for diverse practical applications. Therefore the surface treatment engineers know how to enhance glossiness by changing the plating conditions. However, a material's surface tone which includes glossiness, color, etc. should incorporate the human factor (for user-friendliness) into its design. This means that the human impression of a material's surface tone must be quantified in some way. For this purpose a psychological process, called "semantic differential technique" was used in the study. This technique was applied to several kinds of glossy plating specimens and the correlations between plating conditions, glossiness and human impressions were calculated quantitatively. The results were evaluated in terms of applicability to the practical plating design.

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INTRODUCTION

In our "flat world"[1], off-shoring can be seen in every aspect. Both in US and Japan, we are facing the challenge by the global tendency also in plating industries. We have always pursued functionality for materials in advanced countries so far. However, such a society surrounded by so many advanced materials may be a sort of highly stressed one. Since our advanced societies are changing to high quality mature ones, we should take humanity, user-friendliness etc. into materials design more in the future. Materials Surfaces can be considered an interface between environments including human beings and materials themselves. Therefore, materials surfaces should be designed so that the materials could harmonize well with environments and human beings etc. However, there have not been so many ecological and systematic studies in plating fields so far, unfortunately, since there are many unknown scientific factors in the problems and also since those studies can fall just into some restricted cases. In this study, we sought for a new possible and easy-to-use method, based on semantic differential technique (SD method), taking the glossy plating as an example.

EXPERIMENTAL

Six kinds of specimens were prepared by one of authors, Benham. All of them were bright coatings, even though the processes were different with each other. Since the plating processes are not issued in this paper, we call them tentatively as follows: "Pearl Bright Chrome", "Hex Bright Chrome", "Trivalent Bright Chrome", "Bright Black", "Satin Chrome" and "Smokey Chrome". The color tone based on L-a-b system was measured for each specimen by the colorimeter (CR-13, Konica-Minolta)For all of these specimens, 33 epithet pairs were prepared and provided to all trial subjects composed of 21 people older than 21 years old for each author's group. Totally, the number of trial subjects was 63.

First of all, those 6 specimens were shown to the trial subjects. Then the following paper was given to them before the questionnaires.

----------SD questionnaire paper----------

SD Questionnaire for Glossy Plating Samples

by

Dr. Kanematsu, Dr. Barry and Mr. Benham

A semantic differential survey is used to determine human impressions of objects from the scales of epithet pairs. The experimenter will provide you with six different objects to evaluate. A separate survey must be completed for each item. Survey components include an epithet pair (two words which are polar, have opposite meanings) and a scale of seven positions between them. As the object examiner, please mark the position on each scale which best represents the direction and intensity of your judgment.

Sample survey items and choices are provided.

Case 1: If either word (of the epithet pair) on the ends of the scale is very true for your impression, please mark your answer like this:

```
        x
Fair _:_: _:_:_:_: _Unfair
          Or
                x
Fair _:_:_:_:_:_:_ Unfair
```

Case 2: If your impression is pretty true for either word (of the epithet pair) on the ends of the scale, please answer like this:

```
          x
Fair  - : - :  - :  - :  - :  - :  - Unfair
          Or
                              x
 Fair  - : - :  - :  - :  - :  - :  -  Unfair
```

Case 3: If your impression is relatively true for either word (of the epithet pair) on the ends of the scale, please answer like this:

```
            x
Fair  - : - :  - :  - :  - :  - :  - Unfair
          Or
                    x
Fair  - : - :  - :  - :  - :  - :  - Unfair
```

Case 4: If your impression can be applied to both words (of the epithet pair) to the same extent, or if it can't be true for either, please answer like this:

```
                  x
Fair  - :  - :  - :  - :  - : - : - Unfair
```

Attention:

#1: Please make sure that your mark is located just over the line corresponding to your

impression. Don't put your mark on the border.

x

Good example: Fair - : - : - : - : - : - : - Unfair

x

Bad example: Fair - : - : - : - : - : - : - Unfair

#2: Please make sure that you answer all of the questions. Never skip any questions.
#3: Please make sure that you put only one mark on each epithet scale.

As you fill out the questionnaire you may feel that you have already answered the same questions. Therefore, it is important to mention that similar but not identical questions are provided. Please do not go back to any previous questions and do not peek at any upcoming questions in advance. If you feel like déjà vu, do not try to recall the previous questions. Answer the current question as an independent one and continue with the survey. The researchers strongly hope that the examiner will answer all of the questions quickly and in the best way possible.

Thank you very much for your support and for taking the time to complete these surveys. Your contribution to this research project is sincerely appreciated.

OBJECT NAME: _____

OBJECT EXAMINER PLEASE CIRCLE ONE CHOICE: MALE OR FEMALE

Epithet Pairs

stable - : - : - : - : - : - : - not stable

----------to be continued----------

The epithet pairs prepared for the questionnaire were as follows:
Stable-not stable, uniform - not uniform, visible – invisible, warm - not warm, comfortable - not comfortable, massive - not massive, bold - not bold, calm - not calm, round - not round, cozy - not cozy, refreshing - not refreshing, bright - not bright, sophisticated - not sophisticated, metallic - not metallic, shiny – dull, smooth – rough, soft – hard, clear – fuzzy, beautiful – ugly, cool – warm, thick – thin, flexible – rigid, transparent – reflective,

sharp – dull, wide – narrow, light – dark, full – empty, fresh – stale, strong – weak, clean – dirty, new – old, expensive – cheap. For all of these epithet pairs, lots of data were collected. However, in this paper, we focused on the following four epithet pairs among them, being related to the glossiness. Bright – not bright, shiny – dull, clear – fuzzy and light – dark. The data for these four epithet pairs were analyzed schematically and statistically. And finally, semantic differential method was applied to the results. The detailed explanation for SD method can be seen in the previous paper[(2)].

RESULTS AND DISCUSSION

Table 1 shows the color tones measured by the colorimeter for all of the specimens used in this experiment. The color tones were evaluated on L-a-b-system.

Table 1 Surface color tones for specimens used in this study.

specimen	L value	a value	b value
Pearl Bright Chrome	47.2	-1.9	-2.6
Hex Bright Chrome	37.8	-2.1	-4.0
Trivalent Bright Chrome	33.0	-1.5	-2.0
Bright Black	33	-1.5	2.5
Satin Chrome	37.8	-2.1	-3.8
Smokey Chrome	37.9	0.0	2.5

As for the L-value (Brightness), it decreased in the following order.

Pearl Bright Chrome > Smokey Chrome > Hex Bright Chrome, Satin Chrome > Trivalent Bright Chrome, Bright Black (1)

The brightness corresponds to black-white scale and therefore, L value decreases with the increase of blackness. Bright Chrome and Bright Black seemed to be the most blackish at a glance. On the other hand, a value corresponds to red-green scale and b value to yellow-blue one. To make the analysis simpler, saturation was defined as follows and the results in Table 1 were shown in Fig.1.

$$\text{Saturation} = (a^2 + b^2)^{1/2} \quad (2)$$

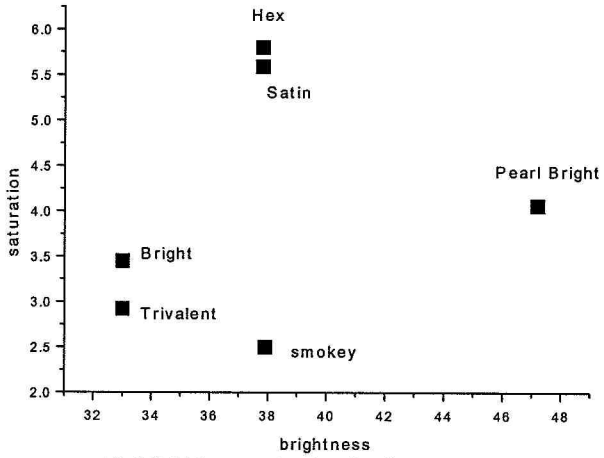

Fig.1 Brightness and saturation for specimens

On the other hand, Hex Bright Chrome had the highest glossiness and it decreased in the following order.

Hex Bright Chrome > Trivalent Bright Chrome > Pearl Bright Chrome > Bright Black > Satin Bright Chrome > Smokey Chrome (3)

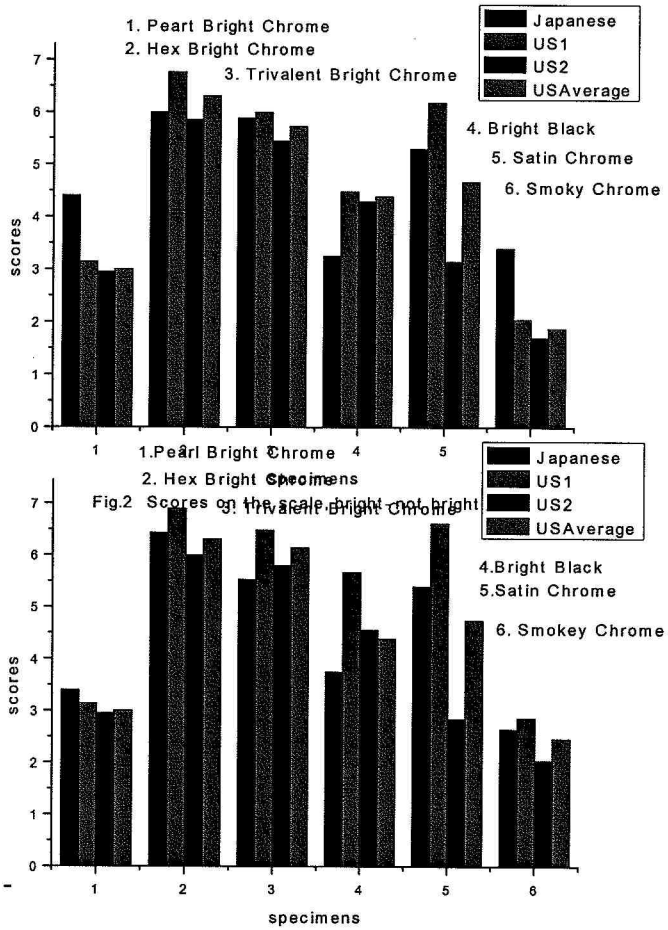

Fig.2 Scores on the scale, bright - not bright

Fig.3 Scores on the scale, shiny - dull.

For all of these specimens, questionnaires were carried out as described in the previous section. Even though lots of data were collected, the following four scales were chosen to analyze: Bright – not bright, shiny – dull, clear – fuzzy and light – dark. Since each scale hade 7 steps between the both edges, the checks were also rated as 7 steps. Concretely speaking, the high order end corresponds to 7 point,

while the opposite to one point. The point was arranged to increase with the brightness viscerally, even though the detailed correlations among these related factors were unknown.

Fig. 2 indicates the scores on the scale, bright-not bright. Each of us, authors, had 21 trial subjects. One of the authors is Japanese, while other two are US citizens. Therefore the trial subjects were classified into three groups, Japanese, US1 and US2, which correspond to the bars from left to right, respectively, for each specimen shown on the abscissa. The vertical axis corresponds to the average score. The scores were the highest for Hex Bright Chrome and were followed by Trivalent Bright Chrome. For both specimens, every group showed very high scores. Even though the glossiness was relatively high, the scores were not so high for Pearl Bright Chrome. Particularly, it is remarkable that US scores were relatively low for the specimen. The specimen's L value was very high shown in Fig.1. It means that the specimen was whitish to some extent. That might be the reason why US scores were not so high. On the other hand, Japanese words corresponding to bright-not bright were Azayakana-Azayakadenai doesn't sounds bright-not bright, strictly speaking. It rather sounds like brilliant. Therefore, the scores might reflect saturation defined by equation (2). The same reason seems to be applied to the result for Smokey Chrome. The specimen also has relatively high saturation value. In such a saturation specimen, Japanese seem to feel the brightness (Azayakasa) more. For Satin Chrome, the results were scattered among groups and the discrepancy was very high. Even though the brightness was very high, other factors seemed to work to some extent.

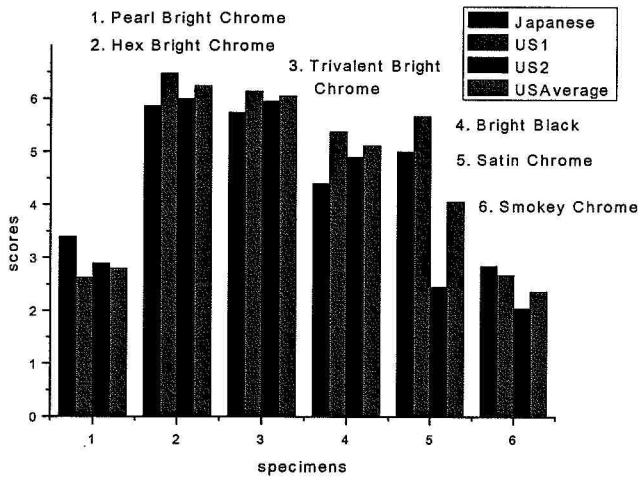

Fig.4 Scores on the scale, clear-fuzzy.

Fig.3 shows the results for the scale, shiny-dull. For Hex Bright Chrome and Trivalent Bright Chrome, all group members felt very "shiny" and the results were compatible with the glossiness data. For Pearl Bright Chrome, the scores were not so high, even though the glossiness value was similar to that of Trivalent Bright Chrome. This reason can be attributed to that the specimen was relatively whitish. For Smokey Chrome, the results among groups were almost the same and the scores were relatively low. However, the values were scattered among groups for both Bright Black and Satin Chrome. Some other psychological factors might work in those cases.

Fig.4 shows the results for the scale, clear-fuzzy. These results didn't correspond to any tendencies shown in Fig.1. It was very difficult to explain the results based on L-a-b system. However, it seems to be relatively easy to explain them based on the glossiness results, except for Pearl Bright Chrome. The high glossiness specimens have higher scores, generally. However, Pear Bright Chrome was an exception, since it has relatively high brightness due to the whiteness. Also for this scale, the results of Satin Chrome were scattered among groups. It suggests some effects by some unknown factors.

Fig. 5 shows the results for the scale, light-dark. Even though the results were scattered among specimens relatively much, the average values seemed to correlate with the glossiness pretty well. The total average values decreased in the following order.

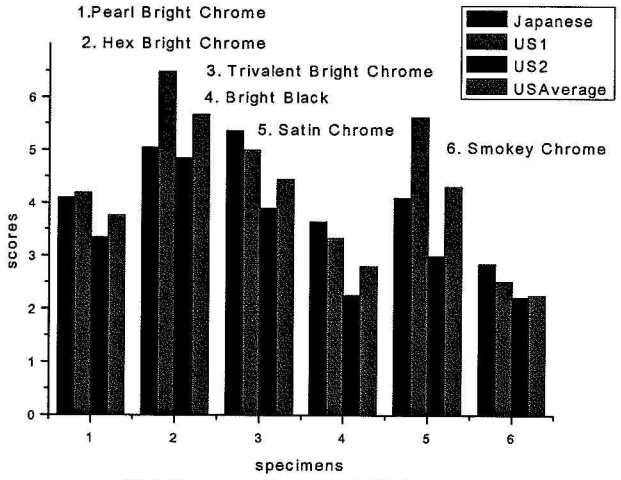

Fig.5 Scores on the scale, light- dark.

Hex Bright Chrome > Trivalent Bright Chrome > Satin Bright Chrome > Pearl Bright Chrome > Bright Black > Smokey Chrome (4)

Being compared with the equation (2), equation (4) shows that the scale, light-dark was very compatible with the physical data for the glossiness, except for Bright Black.

The scores obtained from the questionnaires cannot be explained only by physical data such as glossiness, brightness, saturation etc. completely. The reason can be attributed to that some factors would be involved to human impression to different extents. And the complicate and different involvement can be explained by Semantic Differential Technique which was applied to nickel glossiness coating before[3]. The authors tried to analyze the scores on some scales relating to glossiness based on Semantic Differential Technique.

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