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Perceived Glossiness of Bumpy Surface

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ABSTRACT
The perceived glossiness of 12 flat samples and 18 bumpy samples with various colors and gloss levels is estimated by 13 observers using magnitude estimation technique. Each sample is measured with the gloss-meter as well. It is found that bumpy surface shows lower measured gloss level than flat surface treated with the same level of UV coating. The perceived glossiness of bumpy surface is higher than that of flat surface with low level UV coating treatment while perceived glossiness of bumpy surface is lower than that of flat surface with high level UV coating treatment.

Keywords
Gloss, Perceived Gloss, Gloss Scale, Bumpiness, Texture

1. INTRODUCTION
Most of the studies on the perceived glossiness using physical samples are based on experiments using the flat glossy surfaces [2,3,4]. However, in many cases, exterior surfaces of the commercial products have various textures and those textures affect the perceived glossiness of the surfaces. For example, Y. Ho et al. [1] found that the bumpier surface looks glossier than flat surface after conducting perceived bumpiness and glossiness experiment using graphically generated surfaces.

In this study, perceived glossiness is studied for flat and bumpy surfaces using physical samples to investigate the effect of small bumps on the measured and perceived gloss.

2. EXPERIMENT
2.1 Test Samples

As shown in Figure 1, five types of test sample made with UV coated polycarbonate were prepared. Two types of samples (left side; white and black, 5.6 cm × 11.4 cm) had flat surface and three types of samples (right side; black, blue and pink, 6.8 cm × 18.8 cm) had bumpy surfaces. There are six samples for each type with various gloss levels. Therefore total number of test sample is 30 (5 type × 6 gloss step). The samples with the same gloss step number were treated with the same amount of UV coating.

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The right image of Figure 2 shows the structure of bumpy surface photographed using a confocal laser scanning micro-scope (Olympus OLS3100). This image corresponds to 2.56 mm × 2.56 mm area of the sample. Each bump had oval shape and all the bumps were uniformly distributed. The average roughness (Ra) of the bumpy surfaces was 41.82 μm. The specular gloss of each sample was measured using BYK micro-gloss glossmeter. It is found that the direction of the measurement does not affect the measured gloss data.

Figure 1. Example of test samples used in the experiment

Figure 2. The magnified surface structure

2.2 Psychophysical Experiment
The experiment was conducted in a darkroom and all the samples were displayed in the X-Rite Judge II viewing booth which was illuminated with D65 fluorescent lamp. The illuminance of the booth was 1110 lux and the correlated color temperature was 6450 K at the bottom of the booth.

The magnitude estimation technique was used to estimate the perceived glossiness. During the experiment, a reference sample was given to the observers. The perceived glossiness of the reference sample was assigned as 30. The measured gloss value of reference sample was 73.77 GU at 60° measurement geometry. The observers were asked to quantify the degree of perceived glossiness of each sample compared with the reference sample. There was no limit on maximum value. The test samples were shown in random order. The observers were allowed to grab the samples to examine the surface from the various viewing

positions they want. All the observers had to wear white cotton gloves to handle the samples. In total thirteen observers with normal color vision were participated in the psychophysical experiment. The geometric mean of the observers' responses was calculated for data analysis.

3. RESULT

Figure 3 compares the measured gloss of the samples as a function of gloss step. The same gloss step means the same level of UV clear coating. It is notable that bumpy surface's gloss is much lower than that of the flat surface. The current commercial glossmeter's measuring area is too large to detect the gloss on the surface of each bump. Therefore, the bumps within the gloss measuring area must have scattered the lights quite significantly reducing the measured specular gloss.

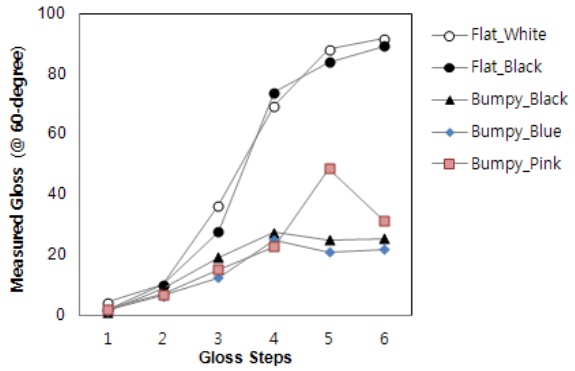

Figure 3. Comparison of measured gloss values

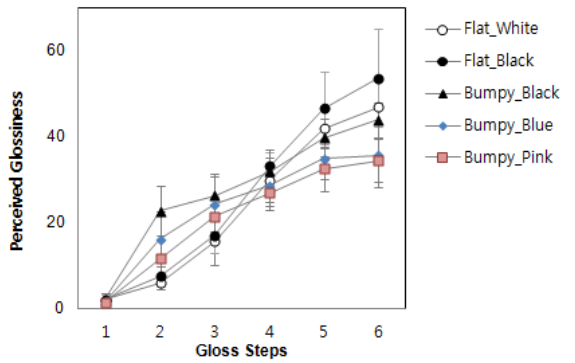

Figure 4. Comparison of perceived glossiness

The perceived glossiness shows very different results compared to the measured data as shown in Figure 4. When the gloss step is lower than 4, perceived glossiness of bumpy surface is higher than that of flat surface while high gloss step samples the results are the other way around.

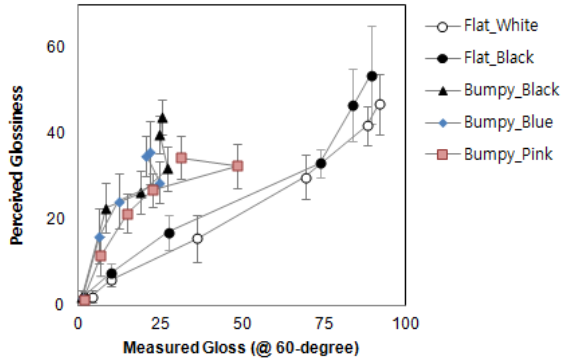

Figure 5. Perceived glossiness vs. Measured gloss value

Figure 5 summarizes the experimental results showing the perceived glossiness as a function of the measured gloss. Figure 5 shows that bumpy surface looks glossier than the flat surface having the same measured gloss, which is similar to Y. Ho et al.'s result. However, it should be noted that as shown in Figure 3, measured data used in Figure 5 does not reflect the real specular gloss of bumpy surface.

The specular gloss of bumpy surface excluding interreflection by micro structures on the surfaces couldn't be measured in this study. However, if the same gloss step can be regarded as the same physical specular gloss, Figure 4 implies that perceived glossiness of bumpy surface becomes lower than that of flat surface when the specular gloss is high while bumpy surface looks glossier when the specular gloss is relatively low.

4. Conclusion

The perceived and measured gloss difference between the flat and bumpy surfaces with various gloss levels were studied using UV coated polycarbonate samples. The perceived glossiness of 12 flat samples and 18 bumpy samples with various colors and gloss levels is estimated by 13 observers using magnitude estimation technique. Each sample is measured with the gloss-meter as well.

The data analysis results found two major findings. Firstly, the bumpy surface shows lower measured gloss value than that of flat surface treated with the same level of UV coating. This finding indicates that the current gloss measuring method cannot be applied to the textured surfaces.

Secondly, perceived glossiness of bumpy surface is higher than that of flat surface with low level UV coating treatment while perceived glossiness of bumpy surface is lower than that of flat surface with high level UV coating treatment.

It is clear that surface structure affects the measured and also the perceived glossiness. However, the experimental result difference between Y. Ho et al.'s study and this experiment indicates that further experiments are needed to quantify the effect of surface structure on the perceived glossiness.

5. ACKNOWLEDGMENTS

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