THE STUDY OF POLYOLEFIN ELASTOMER EFFECT ON SOILING RESISTANCE
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Abstract
Soiling resistance has been issued in automotive industry, which is a measure of soiling or dirt pick-up such as mud on the surface for the interior and exterior of automotive. In this study, the effect of thermoplastic olefin (TPO) composition on soiling resistance was investigated, which is widely used for those applications, and the design guide of polyolefin elastomer (POE) in the polypropylene (PP) compounds for the automotive parts was suggested.

Introduction
Olefin-based PP compounds is suitable for manufacturing the interior and exterior parts of automotive, such as various interior trims, bumpers, and fender guards, etc. The PP compounds have excellent physical properties such as high strength and impact resistance, and are good to resist against breakage, and further shows low gloss characteristics and excellent processability.

Soiling resistance has been issued in automotive industry, which is a measure of soiling or dirt pick-up such as mud on the plastic material for the interior and exterior parts of automotive. In recent years, the soiling resistance of PP compounds for those applications has been deteriorated by the slip agent added to improve the scratch resistance, especially for the interior parts of automotive. In case of scratch resistance, there are specific ingredients such as polydimethylsiloxane (PDMS) in the composition to overcome the problem. However, the specific solution or design guide of material for POE was hardly investigated in the aspect of soiling behavior. Thus we have studied the POE effect on soiling resistance.

The factors affecting soiling resistance are estimated as follows. Friction coefficient may affect on the scratch property, and it is also related to the mar resistance, which is able to be measured by a mar tester. Furthermore the dispersion status of rubber sphere is expected to be the variable depending on the type of POE. In case of POE with low melt index (MI), it is able to provide co-continuous phase, when it mixed with POE with high MI. High molecular weight POE can provide better miscibility with PP matrix.

In this study, the effect of the MI (melt index), the density, the content of POE and high molecular weight POE in the composition was evaluated. The comparison between ethylene-octene (EO) and ethylene-butylene (EB) based POE was also performed. The goal of this study is to obtain a design guide of POE in the PP compounds for good soiling resistance.

Test Method
The soiling resistance of the samples was evaluated by using a universal wear tester and standard soiled fabric, which is the knitted cotton soiled by grass and mud, manufactured by Testfabrics, Inc. The samples of PP compounds with POE to be evaluated are flat embossed specimens prepared by injection molding. Mounting the soiled fabric to the bottom and the specimen to the top of the universal wear tester, a load of 10 N and air pressure of 3 psi were applied. Thereafter, scrubbing motions of 100 times are performed. Then, the soiling resistance was evaluated by delta Y value with a photometer as the degree of soiling.

Materials
In this study, the effect of POE on the soiling resistance of PP compounds composition was examined. Therefore, the components except POE are equally fixed and POE was the only variable. High crystallinity PP resin was used for the experimental work, which had the MI of 30 g/10 min (230°C, 2.16 kg). Talc power with its size of 2000 mesh was used as a filler and its content in the composition was 20 wt%. Black color pigment was added to enhance the visibility of scratch resistance and soiling resistance. Various kinds of POE were used: high molecular weight, EB-based, various MI and various densities. They were all manufactured by The Dow Chemical Company. The content of POE was 10 wt%, 15 wt% and 20 wt% added for the evaluation of its effect according to the POE contents. The POE products used in this study were as follows: ENGAGE 8407, ENGAGE 8200, ENGAGE 8100, ENGAGE 8150, ENGAGE 8842, ENGAGE 7467, ENGAGE 8137, XLT 8677, HM 7387.
Test Results

The sample specimens with standard embossed pattern were made by injection molding process. They were used to evaluate the soiling resistance of PP composite resin samples made up of the materials mentioned above. The soiling resistance was analyzed in the aspect of the MI, the density, the content of POE. The effect of high molecular weight POE and the different type of POE on soiling resistance was also investigated.

Soiling Resistance of Various POE

The overall result of soiling resistance for the samples prepared with the same contents (15 wt%) of different POE is shown in Fig. 1. It was confirmed that there is a difference in soiling resistance depending on POE.

Figure 1. Soiling resistance of various POE

Effect of MI

The results of soiling resistance for effect of MI are shown in Fig. 2. Generally, POE with low MI has a spherical rubber dispersion, which leads to low gloss and low soiling resistance for the final product. However, according to the base PP resin as the matrix of the composition, it seems that there are appropriate ranges of MI for POE which can make the composition have good compatibility. In this ranges of MI, POE exist as small sized particles in the matrix and give excellent soiling resistance. The result shows that the degree of soiling increased if the MI of POE is too high.

Figure 2. Effect of MI on soiling resistance

Effect of Density

The results of soiling resistance for effect of density are shown in Fig. 3. According to the existing researches, it is presumed that the higher the density, the lower the surface friction. Therefore it is expected that POE with the higher density shows the better soiling resistance. However, in this study, the opposite result came out. It is presumed that the other factors such as compatibility are more effective than the density counterpart in the range of density which was applied for the samples in this study.

Figure 3. Effect of density on soiling resistance

Effect of POE Content

The results of soiling resistance for effect of POE content are shown in Fig. 4. As expected, the higher the content of POE, the higher the surface friction, eventually the soiling resistance was deteriorated as the content of POE increased.
Effect of High Molecular Weight

The soiling resistance of a group of POE with low MI was evaluated to investigate the effect of high molecular weight POE on the soiling behavior of the PP compounds. The results of soiling resistance of POE with low MI (below 1.2) are shown in Fig. 5. It is expected that the higher the molecular weight of POE which has low MI, the better the soiling resistance, as the POE of high molecular weight could provide better miscibility within PP/POE matrix.

However, no significant difference in soiling resistance between POE with low MI was found in the results. Even high molecular weight grade (HM grade) which has the highest molecular weight in the samples seemed to hardly affect on soiling resistance. A different type of POE, EB-based grade was also evaluated for soiling resistance. As a result, it showed no considerable effect compared to other EO-based POE samples on soiling resistance. Probably soiling behavior is related to the properties of surface and further research is needed to clarify this phenomenon.

Conclusions

The effect of POE on the soiling resistance was investigated in this study. As a result, it was confirmed that POE can be one of major factors for the evaluation of soiling resistance in PP compounds. The degree of soiling decreased with increasing the MI of POE and the soiling resistance could be better when the composition have good compatibility in the appropriate ranges of MI for POE. Furthermore, the compatibility of POE in the matrix of composition could be more effective than the density on soiling resistance. Also, the degree of soiling tends to increase with increasing the content of POE.

In this study, the design guide of material for POE in the PP compounds for automotive applications with good soiling resistance was provided. As a further step, the effect of morphology and surface friction is planned to be investigated. In addition, the effect of slip agent for scratch resistance on soiling behavior will be also studied.

References