

Development of Automobile Interior Trim parts with Light-Weight Expanded Sheet

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경량화 발포 Sheet 적용 자동차 내장재 개발

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Abstract

At present, fuel efficiency improvement technologies for example light-weight, engine efficiency improvement, design modification, and eco-friendly car are being proceeded due to the tightened international regulations. But there are disadvantages due to the limited technology improvement and materials & products. The research on light-weight of material is good for improvement of engine efficiency is being proceeded. There are representative light-weight methods for example structures, processes and materials of which is the most effective one is material. TEMs (Thermally expandable microcapsules) is one of foaming technology and composited of core-shell structure whose have uniform to increase mechanical properties. In this study, we applied TEMs for lightweight development on the generation TPE sheet of layers of Dash Insulation Pad as automotive interior parts for reducing engine noise. We investigated specific gravity, thickness, mechanical properties, acoustic properties and pore size with 1, 3, 5 wt% contents of TEMs. The specific gravity was reduced 14%, and thickness was increased 13% compare to standard TPE. The tensile strength showed 1.1 MPa to 1.0 MPa with TEMs. TEMs showed 10 times expansion ratio of TEMs by optical microscope. The acoustic properties were measured by Impedance tube and PBNR(power based noise reduction).

1. Introduction

In recent years, the energy conservation and environmental pollution become a serious concern around the world now. Many countries have made new laws or regulations on automobile development and sales, aiming to reduce the CO₂ emission. They are researching and developing to reduce fuel consumption and exhaust emissions. All carmaker makes an effort to achieve engine efficiency enhancement, lightweight, and eco-friendly car in order to satisfy these regulations [1,2].

In their researches for lightweight, foaming technology is representative way for the lightweight automotive materials. It has separated by chemical foaming technology using foaming agent and physical foaming technology using mucell and gas (CO₂, N₂, etc.) [3]. Thermally expandable microspheres are polymeric core/shell particles in which a volatile hydrocarbon is encapsulated by a thermoplastic shell. When these microspheres are heated, they expand and increase their volume dramatically. This volume increase is retained upon cooling, leading to a density reduction about 10~20 times. Since the development in the early 1970's, microspheres have been used extensively by the industry as a foaming agent or light weight filler [4-6].

In this study, we applied thermoexpandable microcapsules (TEMs) on thermoplastic elastomer

(TPE) layer of D/ISO PAD as automotive interior parts to reduce the weight of TPE.

2. EXPERIMENT

2.1. Manufacture

In this study, we manufactured TPE sheets adding TEMs 1, 3, 5 wt% for reducing 10% weight of specific gravity 1.5 TPE sheets. The TPE sheet was tested after expanded of TEMs. Figure 1 shows Dash Insulation Pad(D/ISO PAD) layers of PET felt for sound absorption materials/ TPE sheet for sound insulation materials/ PU foam for sound absorption materials. D/ISO PAD was measured after expanded of TEMs.



Fig.1 Layers of D/ISO PAD

2.2. Measurement

The tensile strength and elongation of TPE sheets adding TEMs 1, 3, 5wt% were measured

according to the ASTM D638 in the universal testing machine (UTM). The specific gravity of TPE sheets with TEMs were tested following ASTM D792 in the specific gravity meter. The size of expanded TEMs was showed by optical microscopy. The transmission loss of TPE sheet with TEMs was achieved using impedance tube according to ASTM E2611-17. The sound insulation properties (of D/ISO PAD were recorded by Articulation index and Power/Train Power based noise reduction.

3. RESULTS

3.1. Results of the TPE sheet properties

In this paper, the properties of TPE sheets adding TEMs 1, 3, 5wt% was studied. Table 1 showed the properties results of TPE with contents of TEMs such as tensile strength, elongation, specific gravity and thickness. The tensile strength was indicated 1.6, 1.5, 1.4 MPa and the elongation was indicated 208, 176, 176% according to contents of 1, 3, 5wt% of TEMs. Adding TEMs to TPE sheet, the specific gravity was decreased 13, 21, 23% and the thickness was increased 14, 19, 23% compared to TPE sheet without TEMs. The pore in TPE matrix which was formed from expansion of core was affected to characteristic of TPE sheet. Figure 2(a) and (b) exhibited cross section of TPE sheet and TPE sheet with TEMs by optical microscopy for checking pore size of TEMs. The TEMs had 400 μm on average pore size and distributed overall. Figure 3 showed the transmission loss of TPE sheet with TEMs. The transmission loss of TPE sheet without TEMs was better than TPE sheet with TEMs. However, TPE sheet with 1wt% TEMs was similar to TPE sheet without TEMs.

[Table. 1] Properties of TPE and TEMs/TPE

	TPE	1wt% TEMs/TPE	3wt% TEMs/TPE	5wt% TEMs/TPE
Tensile strength (MPa)	2.3	1.6	1.5	1.4
Elongation (%)	228	208	176	176
Specific gravity	1.6	1.4	1.3	1.2
Thickness (mm)	1.6	1.9	2.0	2.1

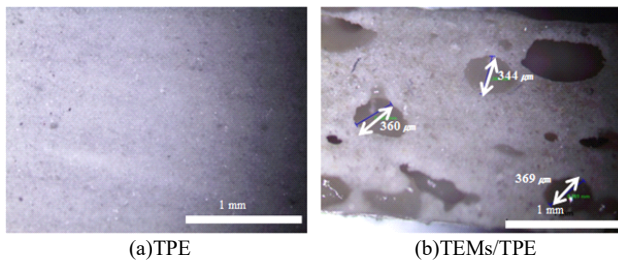


Fig.2 Cross sections of (a) TPE and (b) TEMs/TPE

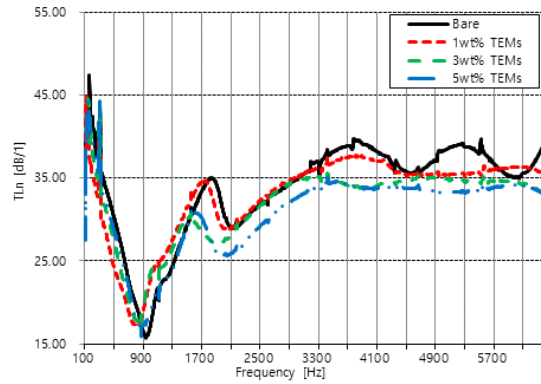


Fig.3 Transmission loss of TPE and TEMs/TPE

3.2. Results of DASH ISO PAD

In results of TPE sheet properties, TPE sheet with 1 wt% TEMs was better than others. We used TPE sheet with 1wt% TEMs (TPE/TEMs) for D/ISO PAD. There was 5% light-weight effect of the TPE/TEMs and D/ISO PAD in Table 2. Figure 4 showed sound insulation property of D/ISO PAD with TEMs that was similar to D/ISO PAD without TEMs. The P/T PBNR was 45.9dB of D/ISO PAD and 46.0dB of D/ISO PAD with TEMs in 400 ~ 8,000Hz in Figure 4(a). The AI is 78.2% for driver, 79.4% for passenger with D/ISO PAD and 79.9% for driver, 80.3% for passenger with D/ISO PAD with TEMs was similar in Figure 4(b) and (c).

[Table. 2] Weight of D/ISO Pad TPE and TEMs/TPE

Weight (Kg)	TPE	1wt% TEMs/TPE
TPE Sheet	4.08 ± 0.03	3.81 ± 0.06
D/ISO Pad	5.42 ± 0.07	5.17 ± 0.05

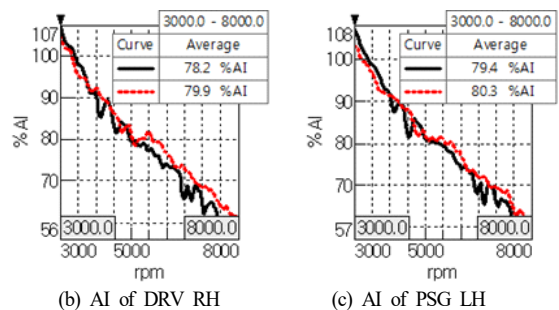
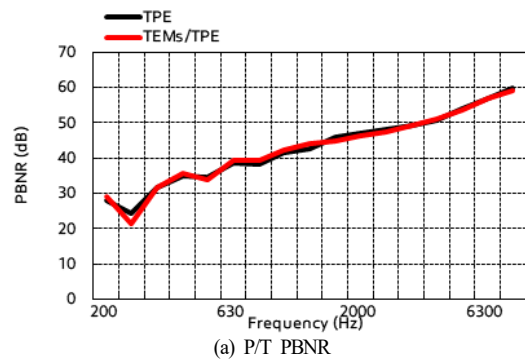


Fig.4 Acoustic results of TPE and TEMs/TPE of (a)Transmission loss (b)P/T PBNR (Power/Train Power based noise reduction) and AI(Articulation index) of (c) DRV RH and (d) PSG LH

4. CONCLUSIONS

In this paper, We produced TPE sheet with TEMs of D/ISO PAD which has light-weight effect and keeps sound insulation property. As added 1wt% TEMs, the specific gravity was decreased 13%, and the thickness was increased 14%. The weight of D/ISO PAD was reduced 5% cause of pores from expansion of TEMs. The pore led to decreasing tensile strength and elongation. TEMs distributed overall in TPE sheet and had 400 μ m pore size resulting from expansion of TEMs 10~20 times. Added TEMs to TPE sheet, the performance of sound insulation performance was similar.

5. REFERENCES

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