DEVELOPMENT OF ELECTROMAGNETIC WAVE SHIELDING MATERIAL BY CONTROLLING COMPOUNDING ORIENTATION OF METALLIC FILLER IN POLYMER MATRIX

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1 Introduction

Our modern life with electrical appliances has much to do with electromagnetic wave. Some produce it incidentally and others utilize it as a medium to signal much data or information, which previously needed long and thick electric wire for transmission. Dealing with the high frequency electromagnetic wave is becoming essential, especially in wireless data communication because of their bad influences on human bodies. As much as the demands for high frequency electromagnetic wave grow, controlling and shielding ability becomes more important.

In this study, we made electromagnetic wave shielding materials and investigated their shielding performance. We also exhibited their stable mechanical properties, such as impact strength, tensile strength and dimension change, etc. Three kinds of metallic filler were used and the effect of contents, particle shape and compounding orientation was discussed.

2 Experimental Section

2.1 Materials

The metallic fillers employed in this study were two kinds of commercial SENDUST in bulk and flake types, tungsten oxide powder and Sn-Bi alloy powder. SEBS-g-MA, PP, EVA 45lx and POE were used to form a polymer matrix. NAUGARD 445 and stearic acid were used as an antioxidant and a lubricant each.

2.2 Sample Making Process

Materials mentioned above were mixed for 15 minutes in twin screw internal mixer heated to 100°C at 100rpm. The mixed sample were pressed at 80°C by hot press machine for 5 minutes and then annealed to room temperature for 4 minutes.

To control the compounding orientation of metallic fillers, i.e., plate-shaped SENDUST powder, in polymer matrix, some samples were processed by two-roll press machine at 90°C for 20 minutes before being processed by hot press machine. Rotation speed of each roll was about 7rpm, and samples were mixed constantly during roll pressing. All the samples that were made by such processes were shaped into thin sheets in millimeter scales.

2.3 Measurement

Samples made by such procedure were irradiated by Network Analyzer generating electromagnetic wave whose frequency ranges from 45MHz to 6000MHz. Shielding ability of the sheets was measured in permeability and power loss both.

ITR-2000(RADMANA) and Instron 4201 were used to measure impact strength and tensile strength each. Morphology of the samples was observed by SEM(Hitachi).

3 Results and Discussion

3.1 Impact & Tensile Test

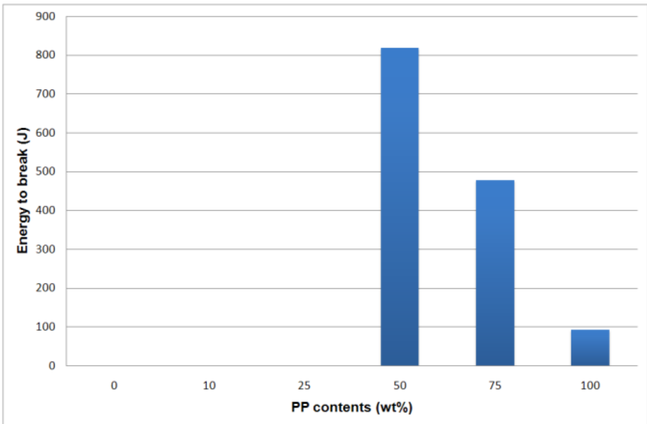

Fig.1. Impact Test

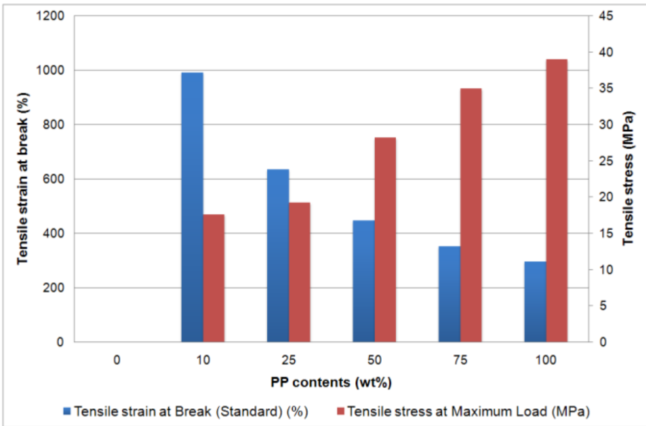

Fig.2. Tensile Test

Fig 1, 2 show impact strength and tensile strength of the samples. Below 25% PP contents, because of their dominant elastic nature, the sheets couldn’t be broken. At 50% PP contents, their impact strength reached the highest value and then gradually decreased with increasing PP contents. On the other hand, tensile strength increases until the maximum PP contents and falls on the lowest value at 25% PP contents.

SEBS-g-MA polymer has rubbery phase and their chains are cross-linked physically. Therefore it hardly breaks their polymer chains and recovers from incident impact. On the other hand, PP polymer has the crystallinity below its melting temperature. It makes them weak against external impact.

3.2 Dimensional Stability of SEBS/PP

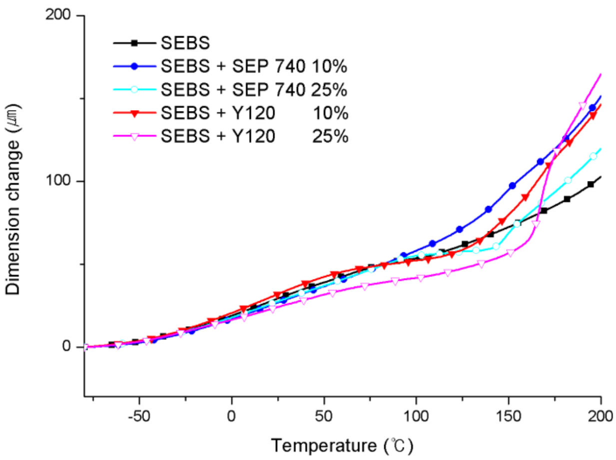

Fig.3. Dimensional stability of SEBS/PP

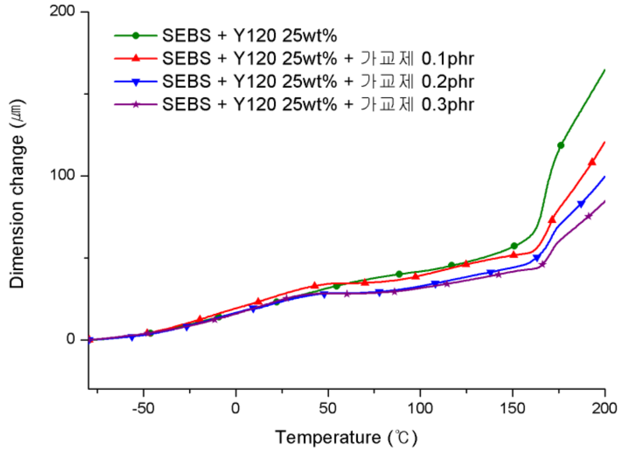

Fig.4. Dimensional stability of SEBS/PP with DCP

Fig 3, 4 exhibit dimension change of the samples. As Y-120 contents increased, dimension of the samples changed less than the samples mixed with SEP-740 because of its high crystallinity. Also with increasing contents of cross-linking agent, DCP, dimensional stability increases.

3.3 Shape of the SENDUST particles

Fig 5 shows different shape of SENDUST particles in both types. As plate-shaped SENDUST particles can be oriented in the same direction, they can block the electromagnetic wave effectively. Therefore we can expect that the oriented SENDUST particles will exhibit more excellent shielding performance against the electromagnetic wave.

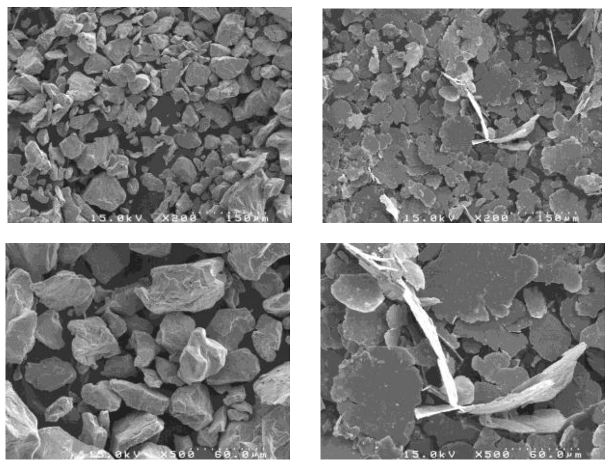

Fig.5. SEM images of SENDUST particles in bulk and plate shape

3.4 Shielding Performance

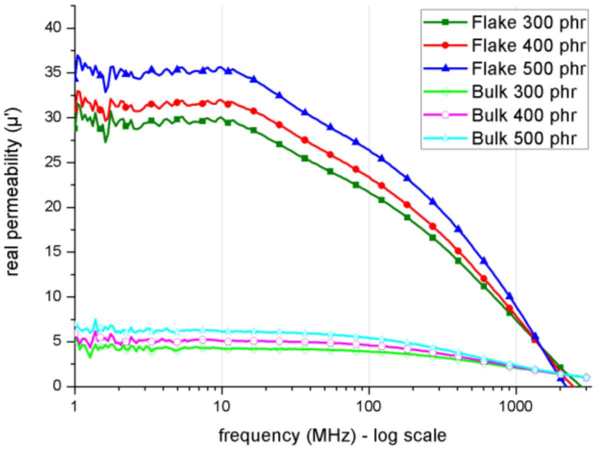

Fig.6. Real Permeability

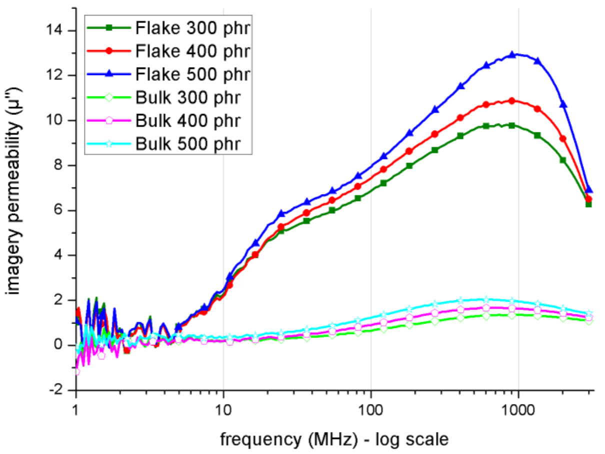

Fig.7. Imaginary Permeability

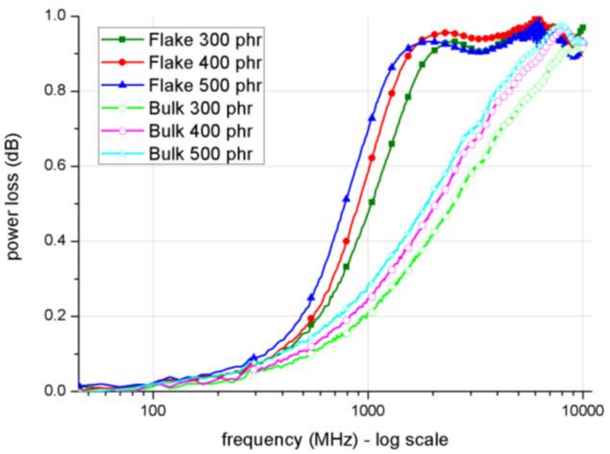

Fig.8. Power Loss

Fig 6-8 shows that flake type SENDUST particles block the electromagnetic wave more than any others. Because of its high aspect ratio, flake type SENDUST particles have higher collision probability than bulk type SENDUST particles. It makes them effective in absorbing energy from electromagnetic wave.

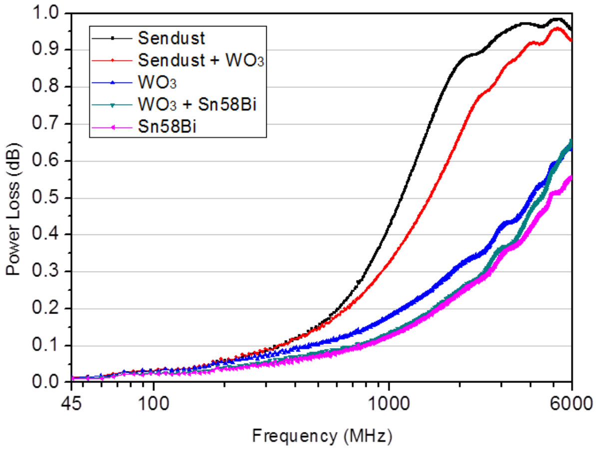

Fig.9. Power Loss with different substances.

Because the energy of electromagnetic wave in this study is lower than that of radioactive rays, shielding materials filled with plate shaped metallic powder show good performance for shielding electromagnetic wave. As flake type fillers in polymer matrix can be easily oriented using open roll press machine, roll pressed samples mixed with the SENDUST powder exhibited the most excellent shielding performance than other samples. In other words, as uniformly oriented SENDUST powder particles form a layered structure, it maximizes the contact probability of electromagnetic wave and the SENDUST particles themselves. Although their good ability for shielding radioactive rays, tungsten oxide and Sn-Bi powder both exhibited almost same capacity for shielding electromagnetic wave.

4 Conclusion

In this study, we made electromagnetic wave shielding materials and investigated their mechanical strength, dimensional stability and shielding performance. Three kinds of metallic filler were used and the effect of contents, additives, particle shape and compounding orientation was discussed.

SEBS/PP compound has the highest impact strength at 50% PP contents and tensile strength of the sample increased with PP contents. Y-120 and DCP exhibited higher dimensional stability than with or without SEP-740.
By roll press machine, compounding orientation of flake type SENDUST particles was easily controlled to exhibit good performance for shielding electromagnetic wave. Therefore we can conclude that controlling particle shape and compounding orientation of metallic filler in polymer matrix have much to do with shielding performance for electromagnetic wave.

References

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