Electromagnetic Shielding and Electrical Properties of Polyurethane Acrylate/E-Glass Composites in the 3-13 GHz Frequency Range

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Abstract

The electromagnetic shielding effectiveness (EMSE) and surface resistivity of UV-cured polyurethane acrylate (PUA) / copper wire / E-glass fabric composites in the frequency range of 3-13 GHz were investigated using a free space measurement. The effect of polyvinyl butyral (PVB) binder on the shielding and electrical properties were searched by using a range of PVB concentrations 2.5, 5, 7.5 % and without PVB. The best EMSE value of 25 dB was obtained in the frequency range of 5-9 GHz by adding 2.5 % PVB. When the addition of PVB was more than 2.5 %, the shielding effect decreased. The sample which contains 2.5 % PVB was showed the least surface resistivity and the best EMSE value.

1. Introduction

With the increasement of electronic devices usage the electromagnetic interference (EMI) shielding became a crucial issue. Electromagnetic waves can cause of unwanted electromagnetic interference that affects the other electronic devices working. Polymers are generally electrically non-conducting but they can be made conductive by adding conductive fillers such as carbon fibers [1, 2], nickel [3, 4], iron, aluminium, silisium [5] etc.

In this study, firstly E-glass untreated standart multi-axial fabric layer ($0^o/90^o$) was wrapped with 60 µ copper wire, then aliphatic urethane acrylate resin with PVB binder at four different concentrations was applied on the fabric surface. The composite was cured by UV light in just 3 minutes. The PVB was used in order to obtain a strong binding between the surface and resin. After the curing process the electromagnetic shielding effectiveness and surface resistivity of the samples were measured.

2. Experimental

E-glass untreated standart multi-axial fabric layers ($0^o/90^o$) (14 cm x 14 cm) were cut then wrapped with 60 µ copper wire. The aliphatic urethane acrylate resin (Sartomer Company CN963E75), photo initiator (Ing. 184) and PVB were induced in ultrasonic bath. Then the resin was poured over the fabric+copper surface and spreaded with a roller. The composite was exposed to the UV light for 3 minutes for the curing process. The cured composites EMSE properties was measured with free space transmission technique (fig. 1) in Network Analyzer Instrument (ROHDE&SCHWARZ), and the surface resistivity was measured in Keithley 6517A Electrometer/High Resistance Meter Instrument.

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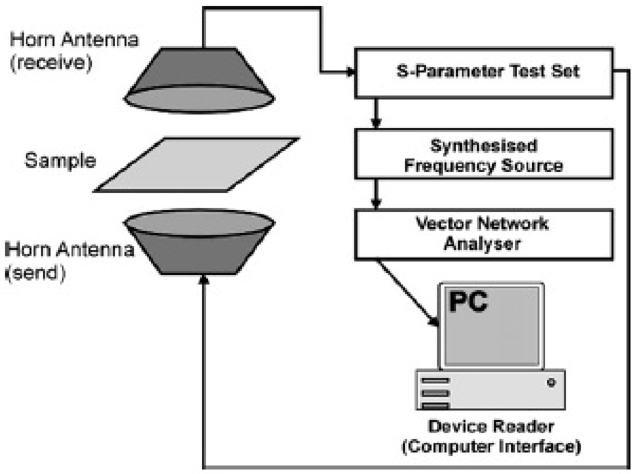

Figure 1 Free space transmission measurement technique [6].

3. Results and Discussion

Figure 2 shows the electromagnetic shielding effectiveness values of the composites in the frequency range of 3-13 GHz. It can be seen that in the 3-5 GHz there is no remarkable change on the shielding value whilst in the 5-9 GHz a quite good shielding value was obtained. The addition of PVB to the composite affected the shielding property especially when the PVB concentration was 2.5 % the best shielding value was obtained. With the increasement of the PVB concentration (5 %, 7.5 %), the shielding value was decreased. The excessive amount of PVB showed negative effect on the EMSE property.

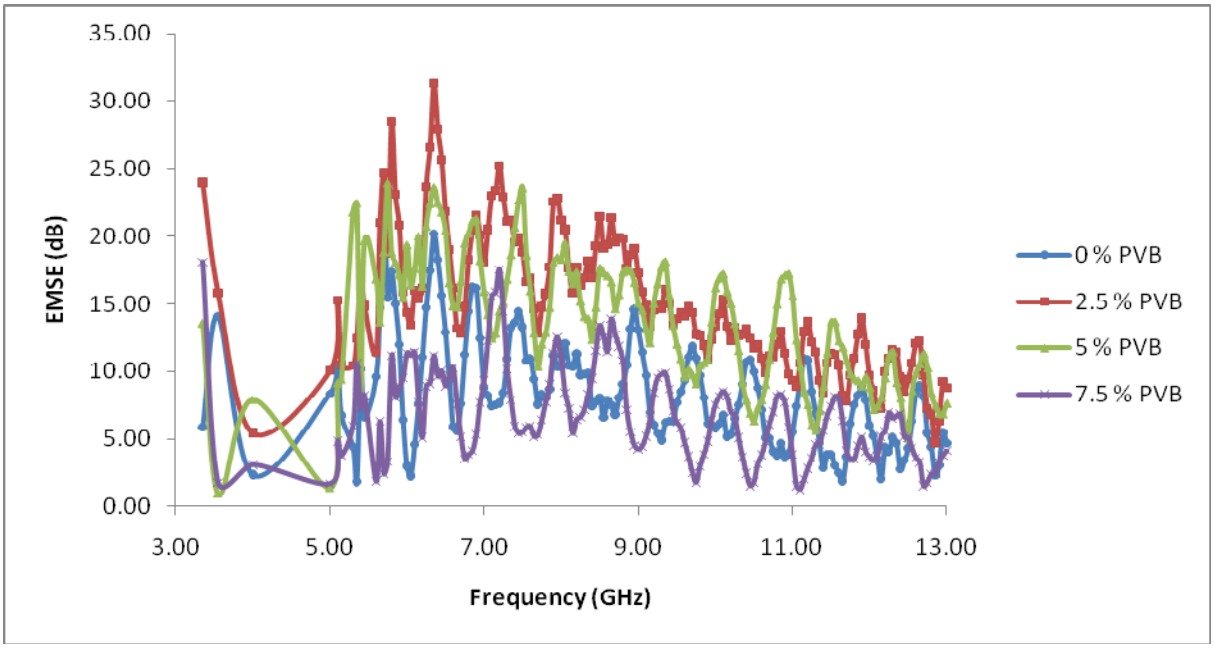

Figure 2 The EMSE values of the composites with different PVB concentrations

The surface resistivity of the composites can be seen in figure 3. All results confirm that conductivity and resistivity are inversely correlated terms. It can be seen that when the addition of PVB was more than 2.5 %, the surface resistivity increased.

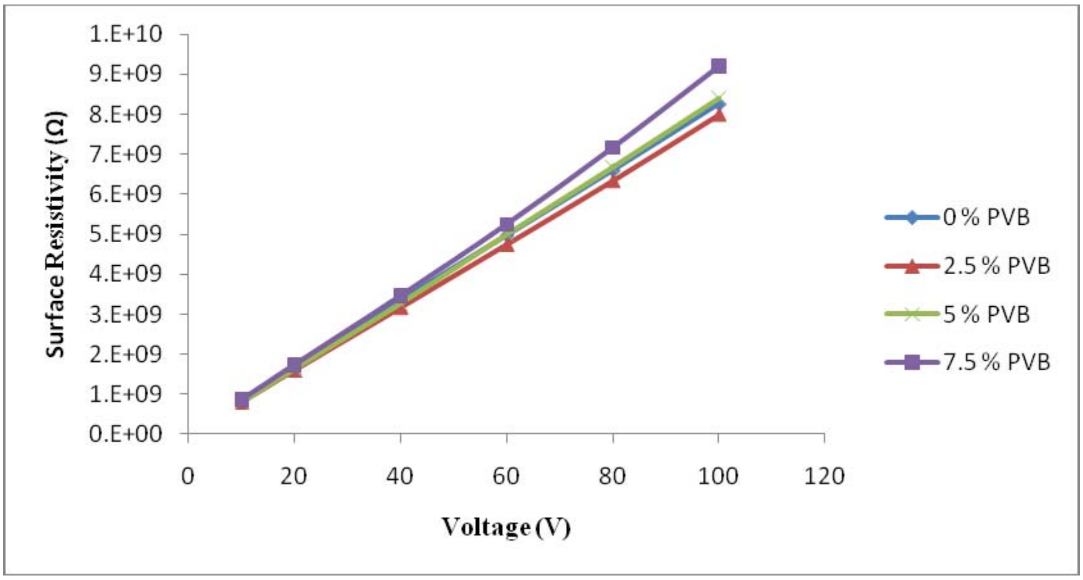

Figure 3 The surface resistivities of the composites with different PVB concentrations.

4. Conclusions

The polyurethane acrylate/E-glass composites with the conductive filler (copper wire) and PVB binder have been investigated on behalf of the EMSE and surface resistivity properties. Specifically the effect of PVB to the shielding was examined. The best EMSE value of 25 dB was obtained by the addition of 2.5 % PVB. More than 2.5 % PVB addition to the composite had a negative effect on EMSE. This counter effect of PVB on EMSE and the effect of PVB on mechanical properties of the composite will be searched in our next study.

5. References

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