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HETEROGENEOUS COMPOSITE MATERIAL FOR ELECTROMAGNETIC SHIELDING

C. Afilipoaei[1], D. Roșu[2], H. Draghicescu-Teodorescu[3]

1. Transilvania University of Brașov, Romania, cezar.afilipoaei@unitbv.ro
2. S.C. COMPOZITE S.R.L., Romania, compozitebv@yahoo.com
3. Transilvania University of Brașov, Romania, draghicescu.teodorescu@unitbv.ro

*Corresponding author: cezar.afilipoaei@unitbv.ro

Abstract: *This original paper presents the process of designing and prototyping two types of heterogeneous composite materials for electromagnetic shielding application. The heterogeneous character has been given by two phase constituent's structure: the matrix represented by epoxy resins (low styrene emission isophthalic gel coat GC and the unsaturated polyester resin based on orthophthalic acid EPR) reinforced with steel wool SW uniformly distributed. The volumetric percentage of steel wool contained by obtained plates was 6.25% when was mixed with GC respective 7.36% in the mixture with pigmented PR. The final plates had a thickness between 3-4 mm along the surfaces.*
Keywords: *heterogeneous, composite, shielding, manufacturing, process.*

1. INTRODUCTION

The association of two or more materials to define a specific structure with specific characteristic still represents a cost/resources efficient solution regardless of the field of interest [1]. The shielding effectiveness of a material it's determined by the grade of absorption, reflection or internal re-reflection of electromagnetic waves energy [2]. From the basics of the *Faraday* cage solution for EM shielding the materials evolved during time highlighting the usage of carbon and different allotropes of carbon (graphite, grapheme, long or short nanotubes)[3], [4], [5]. In the area of fillers ferrous and non-ferrous materials were been used in different weight percentages [6], [7]. Polymers doped with different conductive fillers offers the advantage of a reduced specific weight at the same size compared with a single component constituent and an increased performance at environmental factors (e.g. corrosion resistance).

2. DESIGN AND PROTOTYPING THE COMPOSITE MATERIAL

The starting point in designing the heterogeneous composite material plates was the overall size of the plate. Therefore was chosen a die which was able to produce a 610x400x3(4) mm plate, shown in Fig. 1,assuring enough materialfor cutting the samples needed for mechanical and electromagnetic shielding effectiveness tests. Next step was defining the volume needed for producing the plates at the right thickness. Table 1 describes themasses of resins and steel wool fabric used for composites polymerization. The reinforcement structure as shown in Fig.2 is containing steel fibers oriented at 0° taken from steel wool sponges, which were washed, dried and spin before were integrated into material structure.

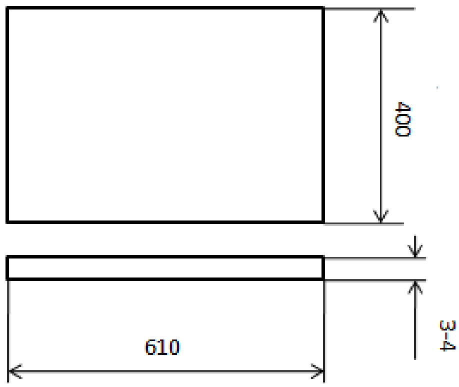


Figure 1: Composite plate sizes

Table1. Materials mass constituents

Material	Resin (g)	Steel wool (g)	Filler [%]	Thickness (mm)
GC-SW	1800	120	6.25	3
PR-SW	2000	159	7.36	4

The wool steel fabric has the role to shield against electromagnetic fields through absorption component, but also is consolidating the strength of material at applied mechanical loads.

Figure2: Wool steel fabric

Figure 3 is describing the method of obtaining the GC-SW material; in the initial step a uniform mass of Gel Coat was applied to the lower side of die followed by wool steel fabric which was soaked into fluid mass. A new addition of resin was applied till the reinforcement element was completely covered by the matrix. The upper side of die was pressed on the top assuring a uniform clamping force given by the threaded fixation. The complete polymerization of material occurred within 24 hours at room temperature (approximately 20°C).

a) b)

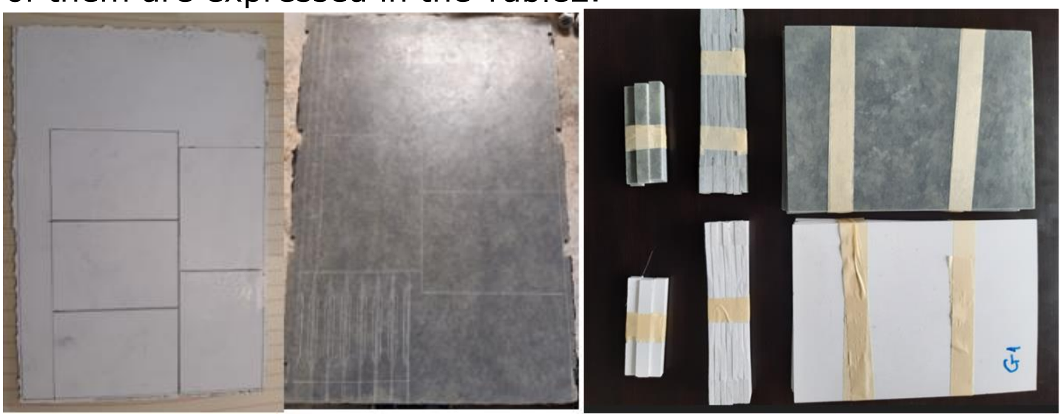
c)

Figure 3:a) GC layer resin; b) wool steel fabric on GC layer; c) closed die

Table2. Resin properties uncured [8],[9]

Material	Styrene content (%)	Density (kg/dm^3)	Viscosity[mPa*s]	Gel time at 23°C(min)
GC	41	-	240	8
PR	32-33	1.1	180	20

The resin curing time is depending by its physical and chemical properties, some of them are expressed in the Table2.



a) b)

Figure 4:a)Cured composite material plates; b) GC-SW samples – white; PR-SW samples – grey pigmented

Figure 4a) presents the composite plates after resin curing the white colored one corresponding to the GC resin and the grey colored corresponding to PR and in the 4b) the samples cut for mechanical and electromagnetic shielding testing.

3. CONCLUSIONS

This paper describes generally the steps followed for designing and prototyping a composite material combining the polyester resins with steel wool inclusion for electromagnetic shielding application. Important aspects when considering molding polyester resins are the time for curing and ambient temperature but also the die surface quality, usually the surfaces of the mold are covered with a non-adhesive material.

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