# THIN FLEXIBLE SYSTEMS THAT ELECTROMAGNETIC RADIATION PROTECTION

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**Abstract**
*Aim of the study was to obtain and analyze thin layers obtained polymer matrix composite materials. Polymer matrix used in this research was siloxane rubber.*
*The goal of present paper consits in the realization and analisis a composit material with polymeric matrix. The synthetic polymeric matrix used at the obtaining composite is represented by a bicomponent silicone elastomer that strengthens itself at the room temperature by means of a poly condensation reaction.*
*Introducing the dust in the polymeric matrix is a simple technology of introducing the particles in the matrix, an ecological technique and without an impact over the environment, contributing to its conservation to obtain the properties of screening adjusted to the proposed goals.*
*There was thus obtained thin films which have been subject to testing. They made such tests optical microscopy, x-ray diffraction and attenuation measurement for materials obtained.Electromagnetic radiation protection concerns mainly: low electromagnetic interference from electronic and communication systems and biological protection, protection that can be achieved with these screens developed in this research.*
**Key words:** *polymeric composites, determine the transmision diminishing carried out and X-ray diffraction*

## 1. INTRODUCTION

Protection against electromagnetic radiation mainly relate to:
• reduced electromagnetic interference from electronic and communication systems;
• biological protection.

*If the equipment, the effects of electromagnetic radiation may be somewhat quantified in terms of interaction between the electromagnetic field and the living beings, which are varied and depend on the frequency, the amplitude of the state quantities of the electromagnetic field and the electromagnetic energy densities the body over time. The literature is replete with articles currently on the influence of electromagnetic fields on living systems.*

*Generating sources of electromagnetic radiation are mainly represented by electrical and electronic equipment (electronic and communications equipment, power lines, electric control panels) that generates electromagnetic radiation.*

It is therefore proposed to obtain a composite material, in particular flexible polymer matrix systems as a protection of electromagnetic radiation of:
• human staff - flexible materials for garments in different sandwich combinations;
• electrical and electronic equipment - flexible materials, tarpaulins and mats, absorbing electromagnetic radiation.

In determining means comprehensive protection from electromagnetic interference are important in two ways:
• shielding against electromagnetic waves (electromagnetic Interference EMI suppresion-suppresion);
• absorption of electromagnetic waves (Electromagnetic Wave Absortion).

Electromagnetic radiation absorbing materials are at in the same time screens of electromagnetic radiation . On the other hand, not all the materials used to mitigate the electromagnetic waves are absorbent. Therefore means of protection analysis will focus mainly on electromagnetic radiation absorbing materials considered as a larger class.

The use of the radio frequency electromagnetic radiation is becoming more frequent. Satellite transmissions, cellular telephone, the use of microwave heating are expanding more and more. In this sense, the net effect of electromagnetic radiation and quantifiable is the thermal which international organizations have established safety rules . Electrical and electronic installations in small and medium power increasingly penetrates everyday life, both in home and in the socio - professional domain especially of people who have occupations or related to telephone , computer , electrical installations or systems from economy.

composite materials, they operate at a low price
Disturbing presence of electromagnetic fields in the environment of our existence is the cause of many failures in the operation of equipment which ensures accuracy and security processes in various fields.

In the future, it provides integration inside of building walls of shielding materials to reduce the disruptive effect of the electromagnetic field against inside equipment. These materials must be cheap and have a shielding efficiency so as to reduce the interference, but does not affect the mobile comunication, which is why in this paper were used with low cost materials, namely rubber siloxane and umpltură agent that according to the literature, if used in the manufacture of of the product. [1-7]

## 2. EXPERIMENTAL PROCEDURE

The materials were processed in the laboratory and contain as mesh reinforced carbon that has been impregnated with a mixture of silicone rubber based composite containing additives fillers - nanocarbon.
So we started from fabric carbon hereinafter PC carbonic mesh.

*2.1. Polymer matrix*

To carry out composite materials with polymeric matrix silicone rubber (siloxanic) as polymeric matrix of RHODOSIL RTV 3325 type that has a **beige-colored** viscous aspect have been used.
The best reticular is achieved at a temperature of $23^0$C in humidity conditions of about 50%. Catalyst 25 is on base of $C_6H_{12}N_2O_4$ (dinytrohexan), this hurries the polymerization reaction (strengthening) of polymer. A ratio of (between catalyst and silicone rubber) = 1:20 PARTS is used.

2.2. *Reinforcing agent*

As reinforcer, it is used mesh carbonic (PC)
We used a mesh-like carbon PNA

**Fig. 1**
**PNA-type carbon mesh used in obtaining composites**

Yarn mesh carbon fiber carbon has a linear density of 1 g/1000 m and a resistivity of max. 100 WCM.
PAN fibers used in applications with high modulus are processed in a manner similar to carbon fiber rayon, except that the tension relatively expensive, it is done in the first phase. PAN fibers are stretched initially between 500-1300% and then stabilized in oxidative atmosphere at 200-280 grdC under tension [8]. The fiber is then charred to a temperature between 1000-1500 grdC. Heat treatment applied by slow molecular ordering maintains tension during stabilization phase. Last stage graphitization occurs at temperatures below 2500 grdC. Applying tension to 2000 grdC will get an increase in ordering graphitic bands.

**2.3.** ***The filling materials***

Agents filling are nanocarbon the dust . Using materials as particles has known a great extension since performs some important advantage such as:
- Low cost;
- Simple technologies of introduction particles into matrix;
- Possibility to obtain isotropic materials.

The filling materials are used to induce some properties, such as increasing capacity of electromagnetic shielding different as their nature and configuration.
FEATURES:
External surface area: 160-200 m2 / g
pH: 5-6.5
Apparent density: 300-330 kg/m3
Ash: 0.3-1%
Residue on sieve: 0.0045 0.01-0.5%
0.5 0.0004-0.001%
Mass loss at $105^0$C: 0.5-0 .9%
Electric Resistance: 0.06-0 .14

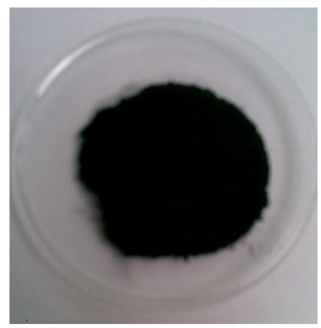


**Fig. 2 Nanocarbon dust**

## 3. GETTING COMPOSITE MATERIALS

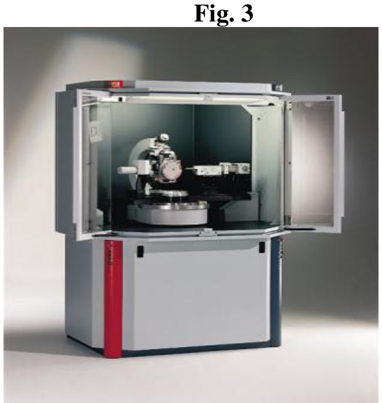
Were processed several types of materials with different compositions. The materials were processed in the laboratory and contain the reinforced **mesh carbonic**, which has been impregnated with a mixture of nanocarbon the dust, based siloxanic rubber with containing filling additives.
Thus, we started from the mesh **carbonic**, PC.
The powdery fillings (nanocarbon, - N) have been dispersed into polymeric matrix – silicone rubber, abbreviation SNC. Mixing has been made at the room temperature. Carrying out composites has been made by the laying mixtures on the **mesh carbonic** (PC) by means of doctor blade technique. The following abbreviations/acronyms, such as PCSNC means polymeric mixture of silicone and nanocarbon laid on the **mesh carbonic.**
The composite materials have been polymerized in open atmosphere at a temperature of about 22 – $25^0$C, for 24 hours. Materials with dimensions of 350 x 350 x 3 mm.
The filler materials in the form of powders were dispersed in the matrix polymer dispersed - rubber silicone rubber. After stirring catalyst was added. Mixing was carried out at room temperature. Making composites

was performed by stretching mixtures. Composite materials are polymerized in an open atmosphere, at a temperature of approx. 22-25 grdC for 24 hours

Materials were obtained with dimensions 35 x 35 cm2 appropriate measurements, diffraction, microscopy and screening.

**4. RESULTS AND DISCUSSION**

**Fig. 3**



**Difractometer D8 ADVANCE of AXS Bruker type**

**4.1. X-ray diffraction**

X-ray diffraction is a determination method of crystalline materials structure. The physical principle is based on the interaction of monochromatic X-ray with atoms electrons in structure. These atoms **scatter** X-ray that further **interwork** between them coming out diffraction maxim at a certain angle against the propagation direction of incident ray.

The position diffraction peaks corresponds to interplanar distances from crystalline structure. Therefore, any crystalline structure will be represented in the diffraction spectrum by a peaks set corresponding to each a certain crystallization direction and will be suitable identified be means of data base (ICDD – International Center of Diffraction Data).

For analysis:

- Difractometer D8 ADVANCE of AXS Bruker type has been used;
- anodic tube used was of molybdenum;
- pass of $0.04^0$;
- scanning speed 1 sec/pass;
- scanning has been achieved between $2\text{-}50^0$ ($2\theta$).

Method is in accordance with SR EN 13925/2003.

Uncertainty of measurement positions of diffraction lines was 0.005%.

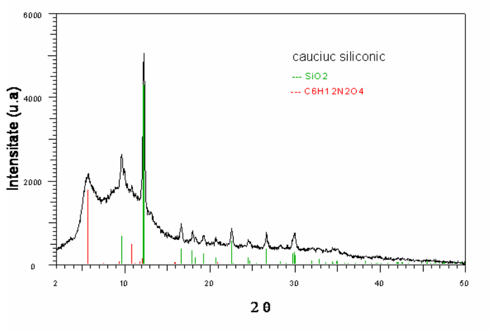



**Fig. 4 Diffractogram of siloxanic rubber**

According diffractometry 4, peaks have maximum intensity for silicon oxide $12{,}34^0$, and for catalyst 25 is on base of C6H12N2O4 (dinytrohexan) the maximum diffraction peak is at the angle of $5{,}78^0$.

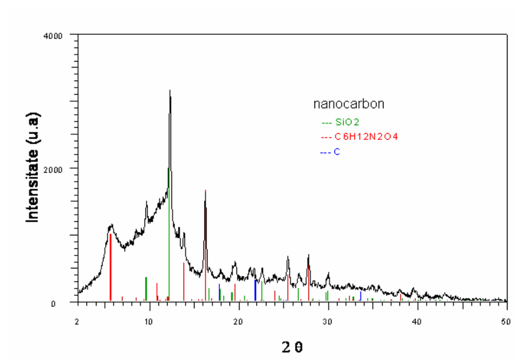



**Fig. 5 Nanocarbon diffractogram**

According diffractometry 5, shows that diffraction peak for silicon dioxide is the $12{,}34^0$, for catalyst 25 is on base of C6H12N2O4 (dinytrohexan) the maximum diffraction peak is at the angle of $5{,}78^0$ and for the carbon we have maximum intensity to $21.91^0$.

**4.2 Optical Microscopy**

Images was obtained used the microscope NU2 Carl Zeiss Jena Germany.

The technical characteristics of microscope are:

- Working in natural light and polarized light;
- Optical zoom up 600 -1000 x;
- Recording with digital camera and processing image on computer;
- Working method is by reflection optical microscopy.

Microscopic analyzes were performed with this type of microscope; zoom was 1:700 with reflected light, brightfield, using metallographic lighting and planacromat objective 25 x, useable also in polarized light.

Digital images were obtained using a video camera with high magnification (up to 500x).

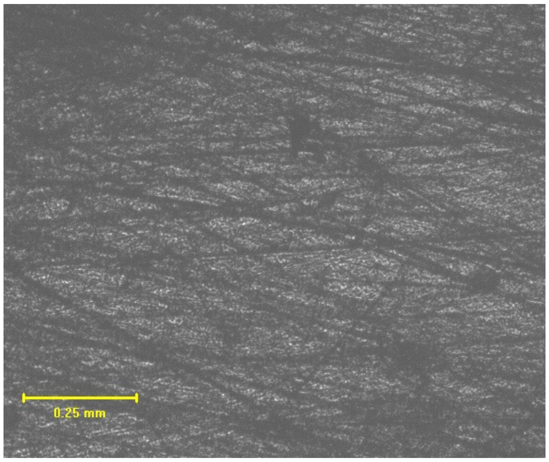



**Fig. 6 S**iloxanic rubber **- 50x**

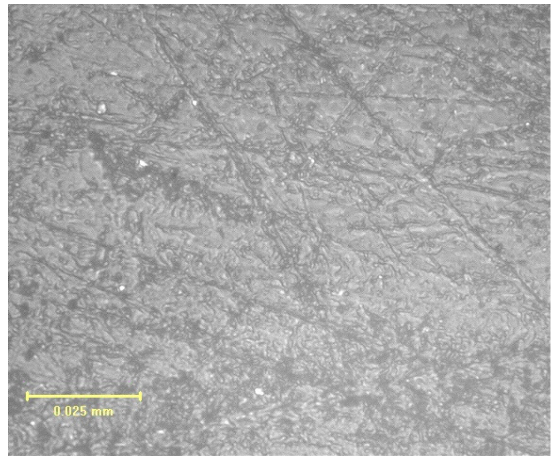



**Fig. 7 S**iloxanic rubber **500x**

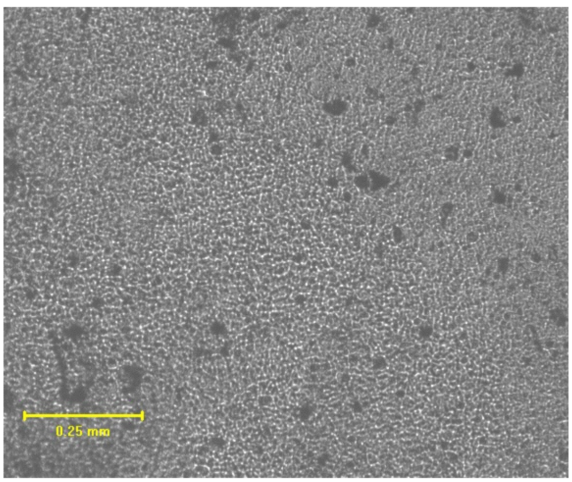



**Fig. 8** Nanocarbon dispersed in silicone rubber 50x

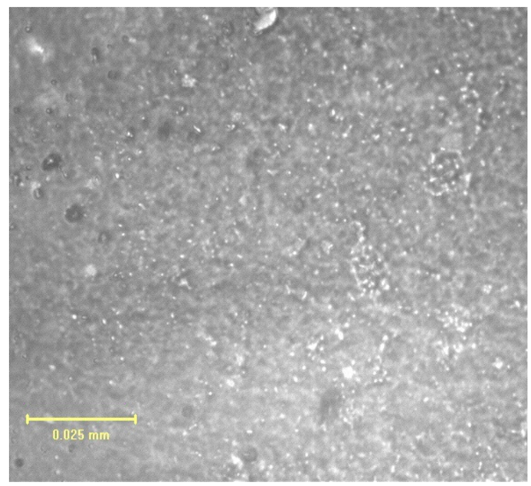



**Fig. 9** Nanocarbon dispersed in silicone rubber **500x**

After optical microscopy analysis were drawn the following conclusions:
- Cured silicone rubber surface shows scratches;
- If mixing is done manually, the material composite is not homogenized;
- there is clusters, most visible in the case of nanocarbon dispersed in silicone rubber.

**4.3.** Measurements of transmission diminishing

The method principle consists in the diminishing measurement of radio transmission chain in two situation: without material and with the material inserted on the transmission chain. The transmission chain can be free space or waves guide. [9-10].

In case of installation used (method in space), the distance between the antennas is constant and vary the signal frequency in a given range . To measure attenuation screen space method was used. First we determined reference level electromagnetic radiation in the environment

In this purpose, the two antennas were placed on both sides of the enclosure measuring 500mm in height (vertical) and the distance of 600 mm from each other (horizontally). Distance from the antenna enclosure wall, was 300 mm. To measure attenuation between the two antennas are interleaved samples (electromagnetic screens). Antenna positioning was maintained distance from the antenna to the screen was kept equal to 300 mm. Power measurement using the same signal in both cases.

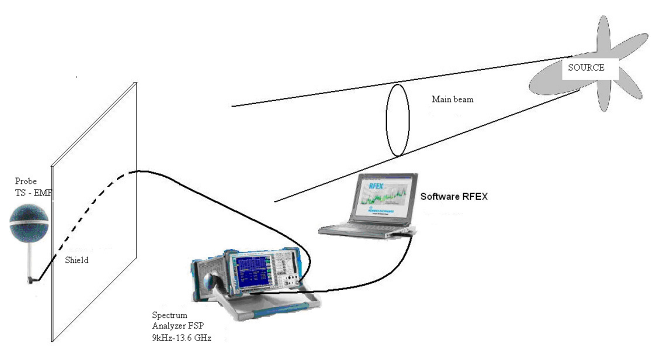



**Fig. 10. The diagram for measuring the attenuation**

Electromagnetic waves emitted by the source pass through the firewall (sample), part of which is absorbed and the other part is received by the probe located behind the firewall.

Electromagnetic waves are emitted by the source (signal generator as type E AGILENT 8257D), pass through the electromagnetic shield (sample), some of them are reflected and absorbed by the shield**,** and only a fraction is transmitted and received by probe (Horn antenna) placed behind the shield.

Spectrum analyzer directly measures the electromagnetic radiations attenuation in decibels (dB).
Spectrum analyzer measures the power before you meet Received firewall and the probe. RFEX softwa is calculated using attenuation.
As a material can be considered efficiently in point of radio diminishing, this must perform a minimum diminishing of 20 dB in band of work frequency.

**Fig.11 Installation for measuring attenuation without sample**

**Fig. 12 Installation for measuring attenuation with sample**

The sample is set up between antennas then an identical signal of the same amplitude as at measurement without sample and measure again the signal noting the obtained values is generated. The diminishing is calculated and plots of diminishing graph depending on frequency.

Samples were characterized dimensions of 350 × 350 × 3 mm, and the temperature measurement tests were conducted to mitigate the material was 24$^0$C..
Tests were conducted according to EN 50 147-1:1999 and PI-02 INCDIE ICPE-CA Bucharest.
Note that, for a material to be considered **efficient** in terms of mitigation (masking) radio (microwave), it must provide a minimum attenuation of 20 dB in the frequency of work.
Materials designed to be suitable for this goal, each of them provide electromagnetic shielding between 40 and 65 dB.

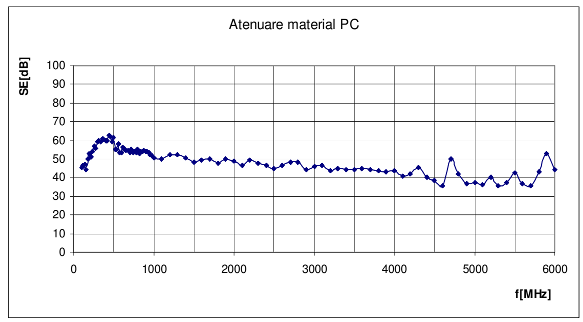



Fig.13 **Variation of the transmission attenuation (dB) frequency, the sample material, PC**

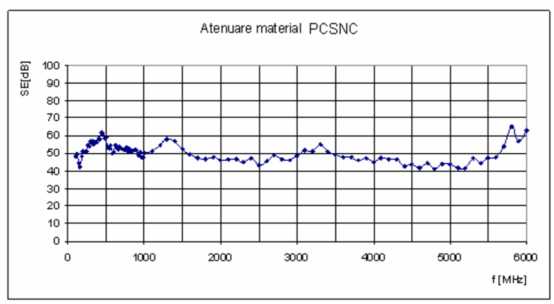



Fig.14 **Variation of the transmission attenuation (dB) frequency, the sample material, PCSNC**

As seen in Figure 13 attenuation was measured between 0 and 6000 MHz and its values are between 35-62dB with a 40dB average for mesh carbon.
For Figure 14 attenuation is between 40 and 60 dB with an average of 50dB on the frequency interval 0-6000MHz composite material so nanocarbon fillers provide electromagnetic shielding.

## 5. CONCLUSIONS

• Materials obtained fit for the purposes for which they were processed, respectively tilt and / or sheathing, providing electromagnetic attenuation between 40 and 70 dB.

• Electromagnetic attenuation for these materials is mainly by activating the electric component of the electromagnetic field.
• Ensuring effective protection by "disguising" electronic equipment, ensuring attenuation of approx. 62 dB. Protection of the human factor by manufacturing of clothing items using such materials.
• electromagnetic pulse attenuation to 62 dB;
• Material flexible, easy to wear;
• Adherence to various surfaces;
• Resistant to use;
• Available in different thicknesses;
• Can manufacture tarpaulins, carpet protection, protective suits, radar absorbent curtains.

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