EXPERIMENTAL RESEARCH AND COMPACTION BEHAVIOUR MODELLING OF MATERIALS COMPOSITE WITH POLYMERIC MATRIX

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Abstract : *The aim of the present paper were to determine compressibility behaviour of post-compacts depending on compaction pressure for the materials obtained in laboratory that contain metallized netting like reinforcement material and powdery nanocarbon as filling agent . Determination of polymeric composite on basis of silicone rubber with additions like nanocarbon with 20 wt.% nanocarbon , powder mixtures' compressibility was performed in mechanical testing machine for static materials, LFM model , Walter & Sai AG Switzerland at pressures 30kN. Determining the characteristics of material was based on the regression analysis . Modulus of elasticity of the test samples was determined appropriate range 0,1 ÷ 0,3% deformation, corresponding to the maximum correlation coefficient derived from regression of the experimental data. The synthetic polymeric matrix used at the obtaining composite films is represented by a bicomponent silicone elastomer that strengthens itself at the room temperature by means of a poly condensation reaction. The paper shows up the research results on processing and characterization of composite materials with polymeric matrix (silicone rubber).*

Keywords*: silicone rubber, polymeric composite, silicone rubber, plated netting, nanocarbon*

1. INTRODUCTION

The powder metallurgy (P/M) is one of the advantageous material processing techniques used to consolidate particulate matter, both metals or/and non-metals, with an isotropic distribution of particles in matrix, at good dimensional accuracy and in an economical manner.

In the manufacturing process of metal powders, the forming step from P/M processing of powdered metal or metal matrix composite has a very important role.

For obtaining of very good properties of final product, especially high strength, good elongation after pressing and sintering [1-14], it is necessary that the metal based powders have high compressibility (95-96 % compactness or theoretical density) and very good fluidity properties.

The pressing capacity or compressibility of powders is one of the most important technological characteristics of the metallic powders and represents the ability to reduce the volume under pressure.

Under the action of compression, plastic composite begins to deform. Breaking compression is controlled by shearing of matrix and not the particle, therefore, the behavior of compression depends on the nature and properties of the matrix.[15,16,17]

Accurate knowledge of the mechanical properties of materials used in various industrial products is a prerequisite for effective use of them. The physical properties of materials (strength, elasticity, brittleness, creep, hardness, fatigue) determines the behavior of the parts in the assembly in which they are included and subjected to mechanical stress, thermal (expansion), electrical (conductivity), technological (workability) chemical (corrosive) etc..

The mechanical properties of the product are defined by a number of characteristics, expressed qualitatively, by a number of parameters and determine the manner their behavior under certain conditions.

Determination of characteristics mechanical testing of materials is doing after trying on special machines corresponding aiming at the behavior of the samples before tear and the manners of fracture appearance.

Mechanical testing of compressive strength of materials enable tracking the behavior of the material and the characteristic parameters by analyzing the dependence between the applied voltage and the corresponding linear specific deformation.

2. STATIC COMPRESSION TEST

Compressive strength R_c is equal to the maximum force F_{max} related breaking unit area A. Depending on the nature of the test material, the specimens will have different shapes and sizes. For the compression test pieces made of the same material, the compressive strength depends on a number of factors such as:

- Characteristics of the sample bodies (shape, size);

- Proper test parameters (speed test);

- Expression of the friction forces arising from the specimen-contact surface of the press platens.

The compression test pieces used for determination of compressive strength is boron, and the dosing method was to obtain the necessary materials to composite materials according to the recipe, as follows (like as the figure 1): weigh the empty capsule, after which it was added the required amount of the siloxane rubber and hardener; is mixed with a rod the two components to mix for 30-60 seconds, after which the powder is added, in this case, the nanocarbon powder .

Homogenize again with the aid of a doctor blade technique is spread with a spatula made of a mixture layer on one side of the plated netting. After crosslinking (24 hours) is deposited and the other side of another layer of metal mesh material and leave the open atmosphere without special storage conditions at 22 -25^0 C.

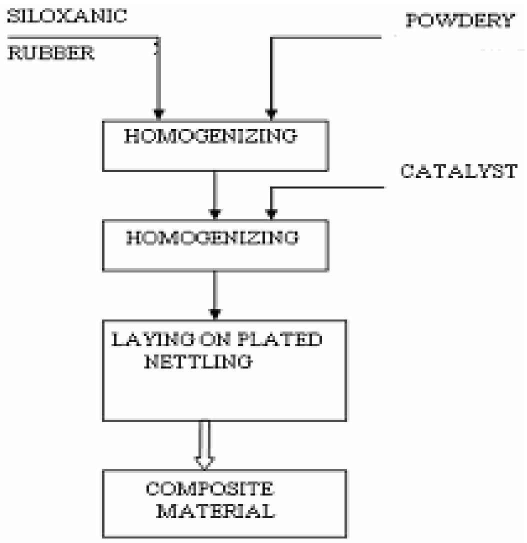

Fig.1 The method for obtaining composite materials

3. RESULTS AND DISCUSSION

Compression tests were performed in the laboratory Characterization and Testing Materials and electrical products, the National Research Institute for Electrical Engineering - Advanced Research (ICPE-CA) using mechanical testing machine.

Testing machine is universal testing machine model LFM 30kN, Walter & Sai AG Switzerland, presented in Figure 2.

Fig.2 Mechanical testing machine

The compression test pieces were tested with machine from figure 2, equipped with data acquisition card . DION is the name of the software with which the data are processed . Data were taken at intervals of about 0.1 s as ASCII files containing each point of measurement , amount of force taken by the machine force transducer and specimen deformation values .

The compression test pieces writes and locks into position to be tested to the press. The specimens were fixed , the line between the jaws of the test machine (which must be flat , rough and smooth) , aiming at a better cross them. Then, they were applied slowly , gradually and continuously - the compressive load .

Determining the characteristics of material was based on the regression analysis. Young`s modulus of the compression test pieces was determined appropriate range 0,1 ÷ 0,3 % deformation , corresponding to the maximum correlation coefficient derived from regression of the experimental data .

Fig.3. The shape of samples PMST and ST

Table 1. Size values for samples PMST and ST

Number and name of sample	*Width of sample [mm]*	*Thickness of sample [mm]*	*Tensile strength [MPa]*
PMST 1	*7.8*	*10.2*	*441.02*
PMST 2	*8.2*	*10.2*	*397.22*
PMST 3	*7.2*	*10.7*	*431.26*
PMST 4	*9.0*	*10.4*	*355.07*
ST 1	*8.0*	*8.0*	*466.02*
ST 2	*7.4*	*9.0*	*436.93*
ST 3	*7.0*	*7.8*	*542.59*
ST 4	*7.8*	*9.8*	*394.99*

The results of compressive strength were obtained by testing samples which were applied compressive force perpendicular to plated netting and are presented in Table 1.

The 8 samples, wich 4 of each type of material, 4 with plated netting and siloxane rubber without nanocarbon, and 4 with added fillers (nanocarbon) were tested in compression machine, the voltage curves traced - the deformation as follows in figure 5.

PMST is material composite (wich contain ST) composite rubber siloxane and nanocarbon lying on plated netting.

From the two graphs (figure 4 and 5) , we see that there is a high reproducibility of the experiment, the experimental scattering undergone very large. Stress strain compression curves, of the four specimens were forms very close.

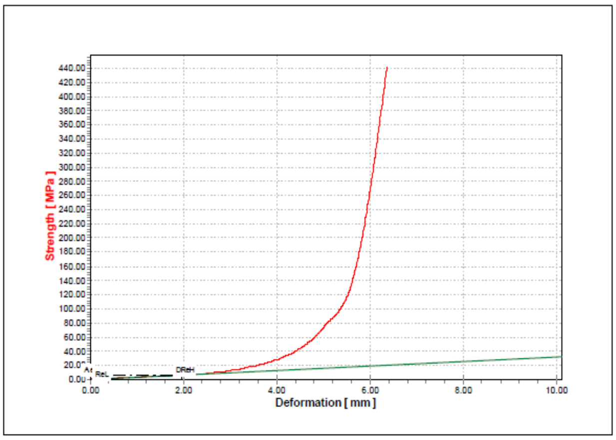

Fig.4 Stress strain compression curve of the specimen PMST 1, curve performed by compression testing machine

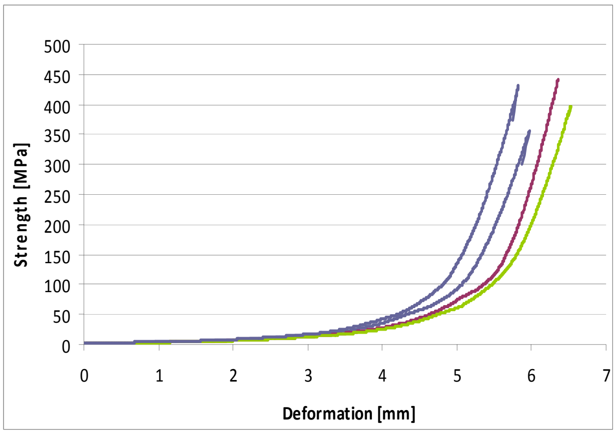

Fig.5 Centralization of stress strain compression curves of the four samples of material PMST

In figure 7, the average Young's modulus is determined from conducted regression data corresponding to the 4 samples of material PMST. For all determinations highlights correlation coefficients ranging between 0.9788 (for specimen PMST 2) and 0.9646 (for specimen PMST 3).

The value of correlation coefficient for determining the Young's modulus is 0,847 (Figure 6)

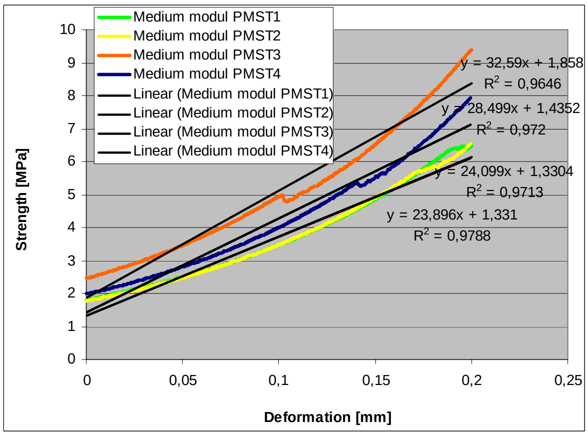

Fig.6 Young's modulus for the 4 samples

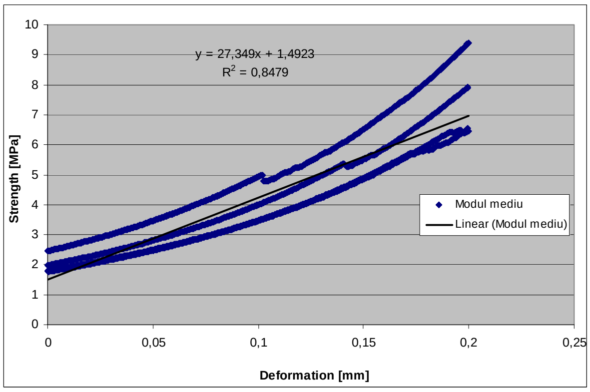

Fig.7 The value of medium modulus for material PMST

According to Table 2, we find that the errors calculated does not exceed 1%, which is well.

Table 2. The results of the determination of the Young's modulus for the material PMST determined by regression analysis of the experimental data on the basis of the correlation coefficient maximum, of figure 6

Symbol sample	PMST 1	PMST 2	PMST 3	PMST 4	Estimate (fig. 7)
Young's modulus [Mpa]	24	23	32	28	27,34
Correlation coefficient	0,9713	0,9788	0,9646	0,972	0,847
Error (%) for the coefficient correlation	0,03	0,8	0,65	0,1	

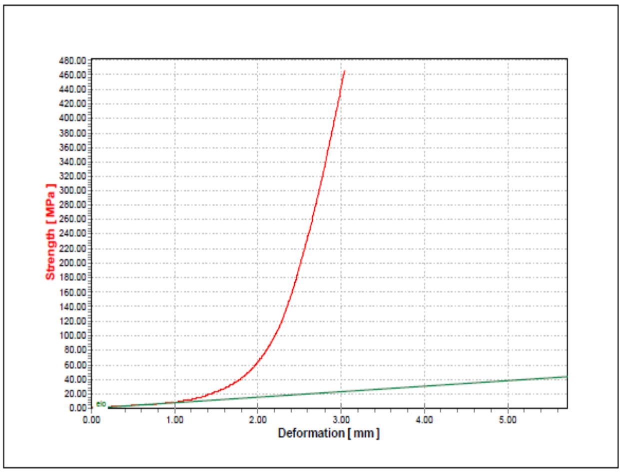

Fig.8 Stress strain compression curve of the specimen ST 1, curve performed by compression testing machine

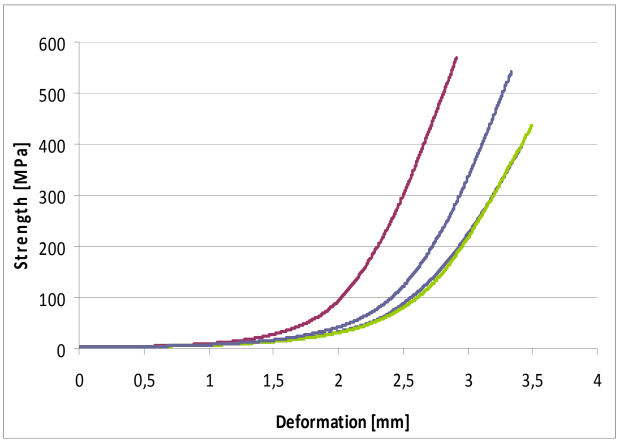

Fig.9 Centralization of stress strain compression curves of the four samples of material ST

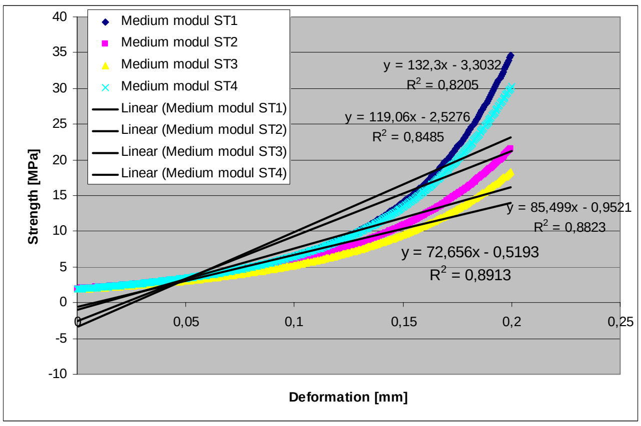

Fig.10 Young's modulus for the 4 samples

Tabel 3. The central results of the determination of the modulus of elasticity for the material ST determined by regression analysis of the experimental data on the basis of the correlation coefficient maximum of figure 10

Symbol sample	ST 1	ST 2	ST 3	ST 4	Estimate (see figure 11)
Young's modulus [Mpa]	132	119	85	72	102.97
Correlation coefficient	0,820	0,848	0,882	0,891	0,7772
Error (%) for the coefficient of correlation	0,89	2,86	1,03	2,06	

According to Table 3, we find that the calculated errors do not exceed 3%.

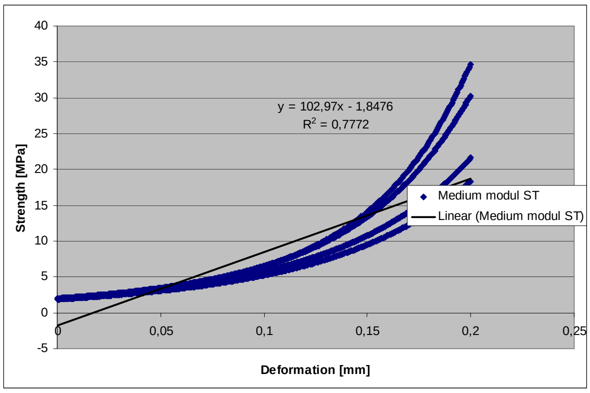

Fig. 11 The value of medium modulus for material ST

4. CONCLUSIONS

According to the results processed to obtain Young's modulus , we find that, for all samples, the modulus decreases when the composite material is stretched over plated netting. For the composite ST (siloxane rubber with the addition of nanocarbon), the Young's modulus of 94 MPa decreases when the composite material is stretched over plated netting , PMST , 27 MPa.

From the analysis of compression we can said that :

- There is the reproducibility of experimental data ;

- The Young's modulus is between 23 to 28 MPa , with a mean value of 27.26 MPa PMST sample and sample ST module is between 72-132 MPa with an average value of 94 MPa.

We note that accurate determination of compressive strength of composite materials with polymeric matrix , sometimes lead to misleading results even if determined by the testing machine performance .

Moreover , all samples were taken from the same plate material and measured characteristics should be very close, what is not happened .

The large differences, especial for the samples ST, could be explained by the fact that the compressive strain of the clamping jaws carried out by the machine can introduce local defects .

For materials without plated netting , I found the compression stress that materials do not break as those that have plated netting, compression test pieces deforms especially like when the compressive force increases. The plated netting breaking into material results in lower Young's modulus , the elastomer degrading the surrounding area .

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