nano emi

pure graphene

Product name: Emigraph

Composition: ABS/Graphene composite material

Product Specification

Matrix:

ABS

Nanofiller:

Graphene flakes

1.0

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nano emi Specialists in 2D materials and advanced graphene composites

pure graphene

ABS/Graphene composite material properties

1. Electrical properties

1.1.EMI shielding effectiveness

The best attenuation results were obtained for the samples with a graphene concentration of 10% (samples 135 and 140). For these samples, attenuation of >60 dB was achieved in the range 240- 320 GHz). The lowest attenuation values were obtained for the samples with the lowest concentration (i.e. 0.5%).

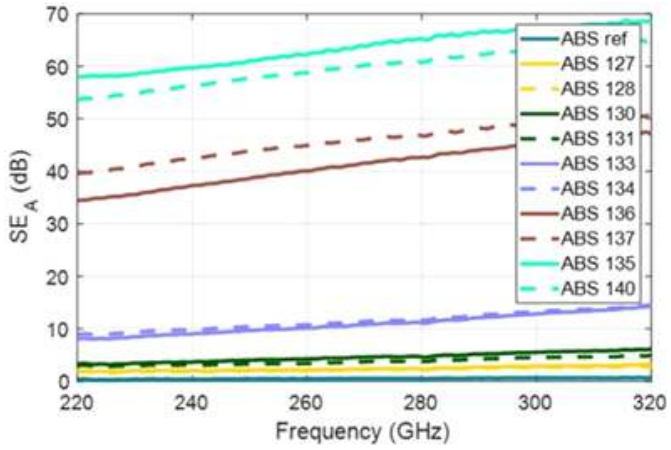

Figure 1: The attenuation results obtained for a series of samples based on ABS and graphene.

The addition of graphene as a filler to the ABS polymer matrix reduces the transmission of electromagnetic radiation compared to pure ABS composite(Fig.2.(a)). The electromagnetic shielding mechanism accounts for 30% of reflected radiation, while the remaining radiation is absorbed (Fig.2(b)).

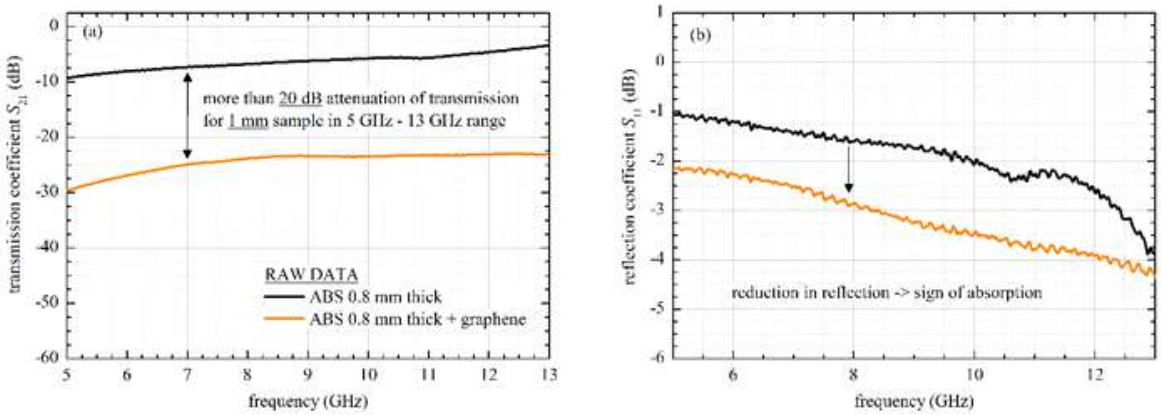

Fig. 2. Comparison: of electromagnetic radiation transmission coefficient for pure ABS and ABS / graphene (a) electromagnetic radiation reflection coefficient for pure ABS and ABS/graphene.

Low frequency shielding of electromagnetic radiation by the ABS / graphene composite material is shown in Fig. 3.

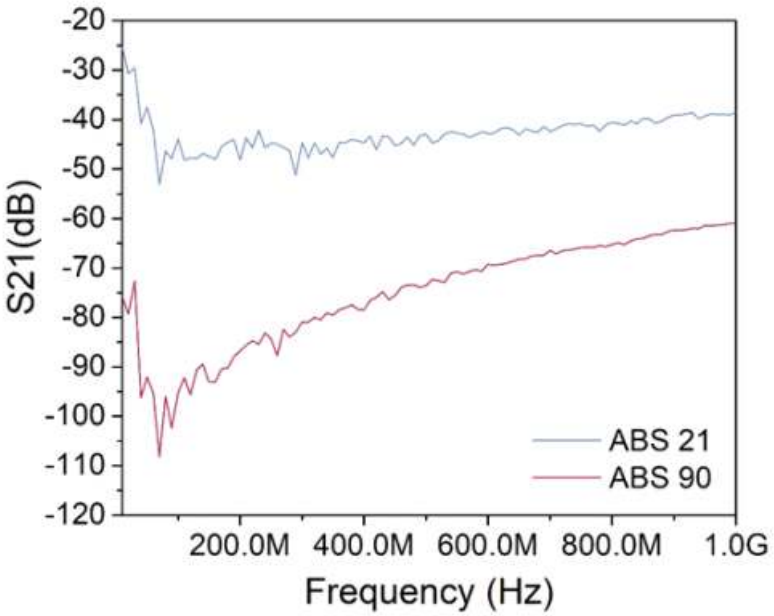

Fig. 3. EMI shielding of nanocomposite in low frequencies.

1.2.Volumetric resistance

Low frequency shielding of electromagnetic radiation by the ABS / graphene composite material is shown in Fig. 3.

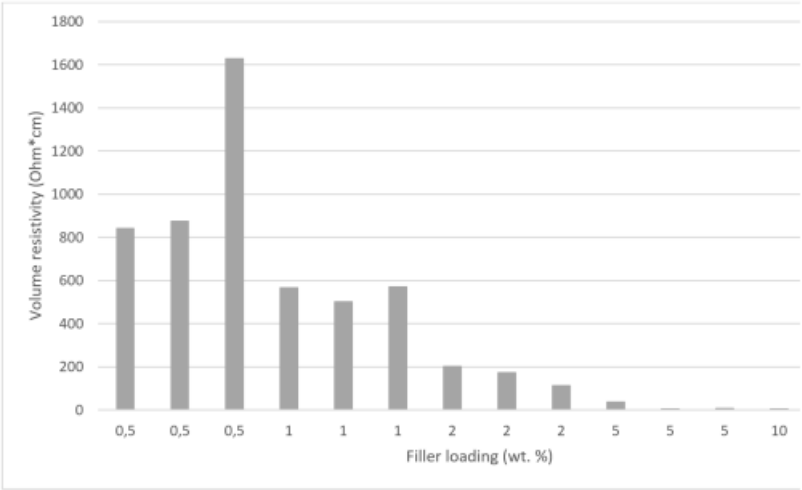

Fig. 2: dependence of the volumetric resistance on the filler concentration.

2. Mechanical properties

2.1.Tensile strength

The measurement will be carried out with a INSTRON 8501 endurance machine and extensometer.

Table 1. Tensile strength measurement results.

Sample nr		Thickness [mm]	Width [mm]	Tensile strength σ_m [MPa]	Elongation e_m [MPa]	E [GPa]
I-1		3,76	9,96	21,1	1,3	2690
I-2		3,76	9,95	19,9	1,1	2790
I-3		3,79	9,96	19,6	1,0	2600
III-1 uv		3,75	9,90	22,8	1,4	3240
III-2 uv		3,76	9,90	21,1	0,99	2910
III-3 uv		3,80	9,95	20,5	0,92	2950

The Figure 3. presents relationship between stress and elongation for I-1 (a) and III-1 (b) samples.

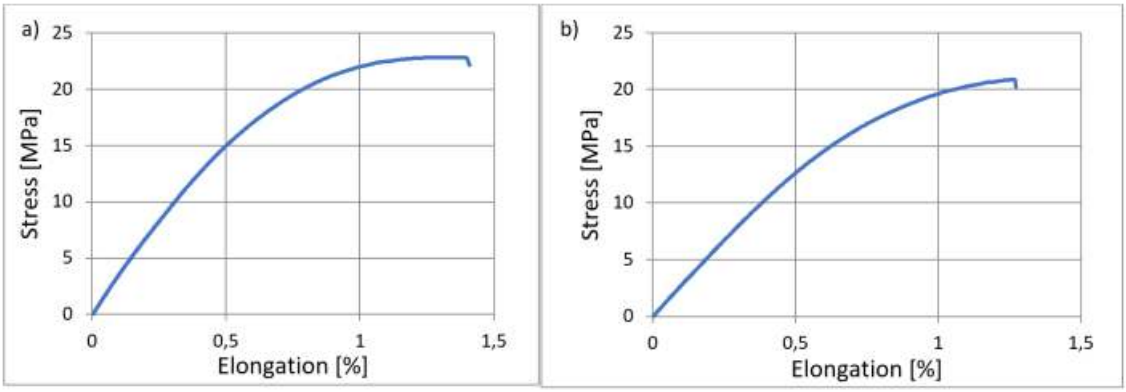

Fig. 3. Stress diagram for samples I-1 (a) and samples III-1 (b).

2.1.Young's modulus

Young's modulus was estimated for a specific deformation and material constant E.

Table 2. Young's modulus measurement results.

Sample No. / Temp. [°C]	1 [MPa]	2 [MPa]	3 [MPa]	4 [MPa]	5 [MPa]
21	2500	2540	2540	2580	2570
50	5650	5570	5580	5460	5470
110*	1480	1570	1540	1500	-

3. Other properties

3.1.Thermal process

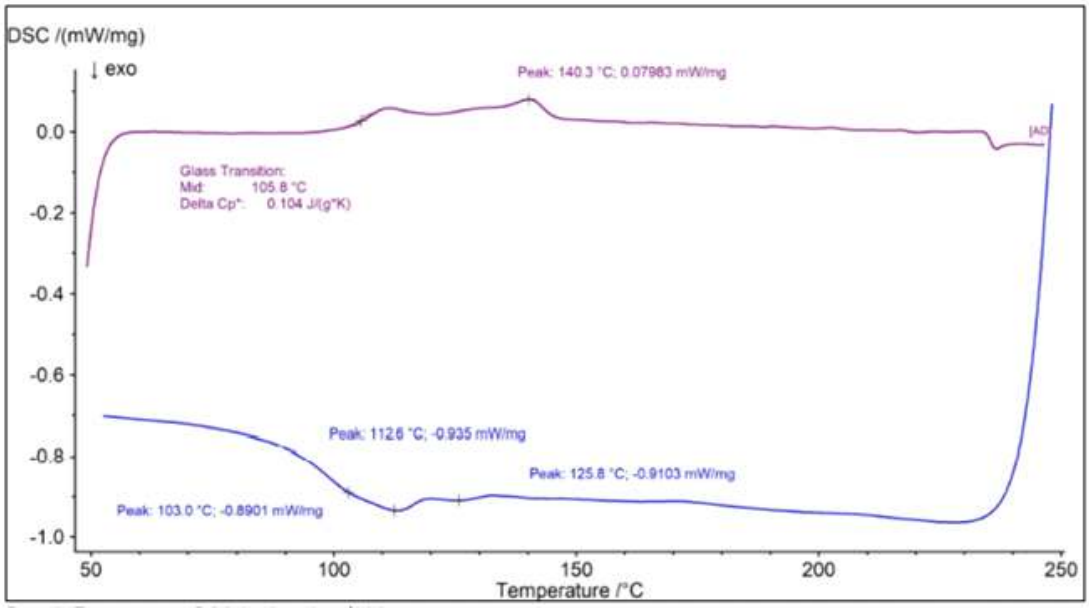

Fig. 4: DSC thermogram of the tested sample in the temperature range of 50-250 .

Table 3. Summary of the results of the DSC study.

Material	Glass transition temperature [°C]
Sample	105,8

Table 4. Flammability test results for first set of samples.

Criterion	Sample No.				
	1_1	1_2	1_3	1_4	1_5
Total burning time with flame for each sample	80	78	81	85	79
Total burning time with flame for all samples	403 [s]				
Time of burning and glowing of the sample after the second application of the burner flame	-	-	-	-	-
Inflammation of cotton by falling drops	YES	YES	YES	YES	YES
Glowing or burning of any sample to the mounting clamp	YES	YES	YES	YES	YES

Table 4. Flammability test results for first set of samples.

Criterion	Sample No.				
	2_1	2_2	2_3	2_4	2_5
Total burning time with flame for each sample	82	80	78	79	79
Total burning time with flame for all samples	398 [s]				
Time of burning and glowing of the sample after the second application of the burner flame	-	-	-	-	-
Inflammation of cotton by falling drops	YES	YES	YES	YES	YES
Glowing or burning of any sample to the mounting clamp	YES	YES	YES	YES	YES

3.2.Density

The density was estimated according to the methodology described in the standards:

- EN ISO 845- Cellular plastics and rubbers- Determination of apparent density
- EN ISO 1183- Plastics- Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pycnometer method and titration method.

Table 6. Density measurement results.

Parameter	Sample 1	Sample 2	Sample 3
Dry weight [g]	38,09	39,2	39,62
Mass in liquid [g]	7,99	9,18	9,52
Weight after removal [g]	38,14	39,25	39,65
Apparent density [g / cm3]	0,998	1,030	1,039

3.3.Viscosity

Viscosity is an important rheological property of injection molding materials as it controls the transport rate of liquid materials which can lead to casting defects such as hot tears and porosity. Most experimental measurements might be performed with rotational and oscillatory viscometers. Viscosity testing was outsourced to Anton Paar. Samples from the same series were subjected to viscosity tests on an oscillating rheometer. It was necessary to perform a viscoelastic test using an oscillating rheometer, because the sample was not yet liquid at the temperature of 180 ° C, which made rotational measurement impossible.

Viscosity for mutual cohesion of viscous and elastic. Viscous are the strength-related deformation properties of the activities that appear at a point. Elasticity is related to the restoration of reversal deformations under the property of properties that disappear immediately after its subtraction. Viscosity is already arising what it is. Elasticity is a measure of a material's ability to recover after deformation. Viscoelastic measurement is shown on a Figure 5.

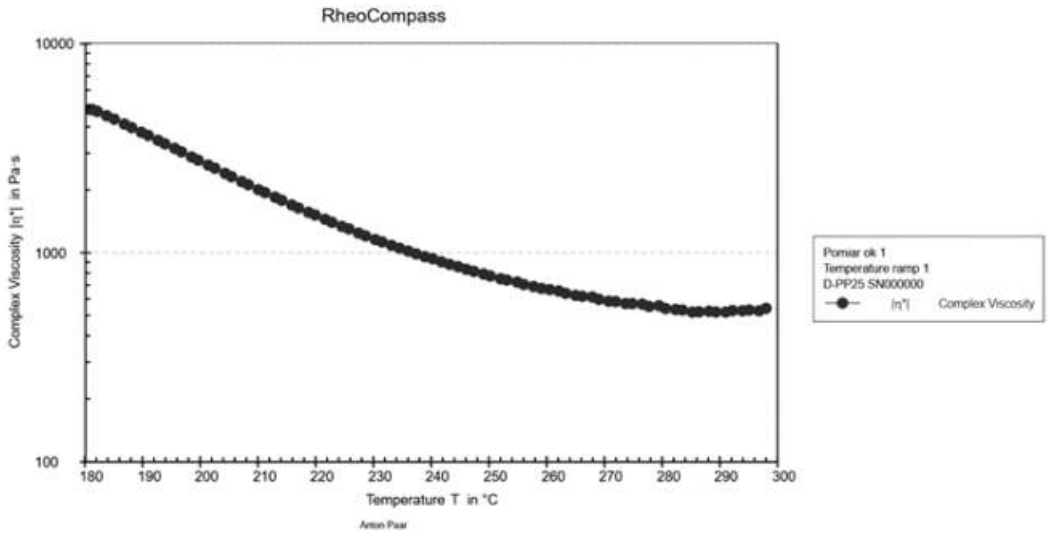

Fig. 5. Viscoelastic measurement result

The measurement was performed in the polymer processing temperature range of 180-300°C. As it can be seen, the viscosity of the viscoelastic medium decreases with increasing temperature. At a temperature of ca. 285°C, the viscosity stabilizes and remains at the same level even at higher temperatures.