THERMAL BEHAVIOUR OF POLYMER-MAGNETITE COMPOSITES

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Abstract
By the addition of metal-oxide particles to plastics the thermal conductivity of polymers can be increased significantly. Strontium ferrit was used in polymer bonded magnets. Thermal properties of these samples were investigated. Changes of thermal diffusivity (thermal conductivity and thermal capacity) with temperature were measured.

Key words:
thermal conductivity, polymer-magnetite composites

1 INTRODUCTION

Commonly used plastics have a low thermal conductivity. However new applications require new materials with an enhanced or high thermal conductivity. By the addition of suitable fillers to plastics, the thermal behaviour of polymers can be changed up to significant higher thermal conductivity (diffusivity). The higher thermal conductivity can be achieved by the use of suitable filler. Published values of thermal conductivities of the same filler materials in different polymer matrices vary drastically and a comparison of different materials is impossible [1].

Hexagonal ferrites, $MFe_{12}O_{19,}$ ($M = Ba, Sr, Pb$) continue to be important magnet materials in microwave, small motor, and magnetic recording applications. Important material parameters, in these applications are the bulk spontaneous magnetization and its temperature dependence.

2 EXPERIMENT

2.1. Experimental method

We applied pulsed dynamic measurement method using the device ISOMET 2104 (Applied Precision, Ltd.) with the surface probe. Were measured at laboratory temperature and at chamber using temperatures 30 ˚C, 40 ˚C, 50 ˚C.

2.2. Material

Measured samples were too phase composites (table 1).

Phase	Material	Density g/cm^3
matrix	Natural rubber	1.10
filler	$SrFe_{12}O_{19}$	4.08

Table 1: Densities of phases

Two samples (No.1 and No.4) with different filler content were measured (table 2).

Sample (No.)	Filler volume fraction (%)	Weight fraction (%)
5	11.9	29.7
3	12.9	31.7
1	13.8	33.5
8	16.9	38.9
9	17.7	40.3
7	18.6	41.7
4	20.9	45.3
6	23.8	49.6

Table 2: Identification of samples

3 RESULTS AND DISCUSSION

Fig. 1 shows the measured thermal conductivity data of the investigated samples. It can be seen, that the thermal conductivity is slihgtly increased from 0.391 W/mK to 0.446 W/mK (sample1).

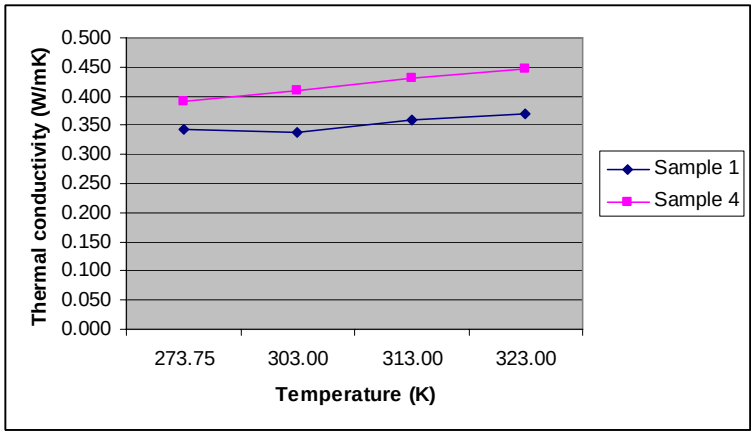

Fig 1: Temperature dependence of thermal conductivity for sample 1 and sample 4

Fig. 2 shows the measured thermal capacity data of the investigated samples. It can be seen, that the thermal capacity is slihgtly increased from 1.601 $\times 10^6$ J/m^{3}K to 1.683 $\times 10^6$ J/m^{3}K (sample 4).

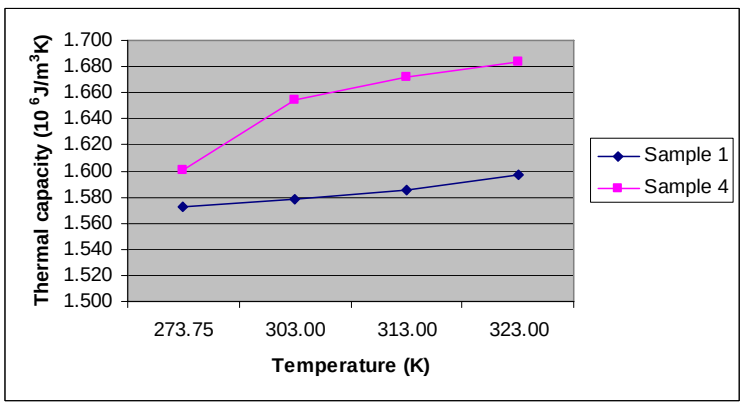

Fig 2: Temperature dependence of thermal capacity for sample 1 and sample 4

Fig. 3 shows the measured thermal diffusivity data of the investigated samples. It can be seen, that the thermal diffusivity is slihgtly increased from 0.245 $\times 10^{-6}$m^2/s to 0.265 $\times 10^{-6}$m^2/s (sample 4).

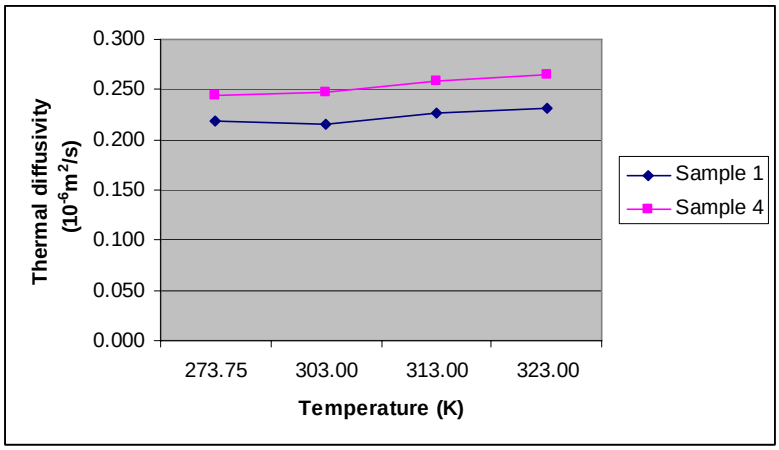

Fig 3: Temperature dependence of thermal diffusivity for sample 1 and sample 4

A change of the thermal diffusivity with temperature is caused by phonons and is related to the mean sound velocity υ and mean free length ℓ of phonons acording to:

$a = \frac{1}{3} \nu \ell$. Thermal diffusivity is changed due to the changed bulk modulus K, which results in changed phonon velocity $\nu = \left(\frac{K}{\rho} \right)^{0.5}$ [1].

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REFERENCES

[1] Weidenfeller, B., Höfer, M., Schilling, F., R.: Cooling behaviour of particle filled polypropylene during injection moulding process, Composites: Part A 36 (2005), pp. 345 - 351