INVESTIGATION OF THE POSSIBILITIES FOR APPLICATION OF NORM INTO POLYMER MATERIALS

Vineta Srebrenkoska[1], Vilma Ducman[2], Adrijana Sever Skapin[2], Emilija Fidancevska[3], Biljana Anguseva[3], Vojo Jovanov[3]

[1]*Faculty of Technology, University Goce Delchev – Shtip, R.Macedonia, Krste Misirkov 10-A, Shtip, vineta.srebrenkoska@ugd.edu.mk*
[2]*Slovenian National Building and Civil Engineering Institute, Dimiceva 12, 1000 Ljubljana, Slovenia*
[3]*Faculty of Technology and Metallurgy, Ss.Cyril & Methodius University, Skopje, R.Macedonia, Ruger Boskovic 16, 1000 Skopje*

Abstract

There is growing trend towards the development of composites with low environmental impact and good commercial viability. Over the last few years different kinds of waste materials have been successfully utilized as filler in polymer composites with various applications. This not only reduces the production costs but also offers an opportunity for utilization of waste materials thereby reducing environmental pollution. Due to the environmental concerns and disposal difficulties, the utilization of fly ash (FA) as NORM material has become of great importance. Fly ash is promising for fabricating composites which can be widely used in various important fields especially for buildings. The granulometry of fly ash filler and filler blends are reported to be attractive as filler material in polymer composites.

The main aim of this work was to perform estimate the possibilities for preparing of the composites based on fly ash as NORM material.

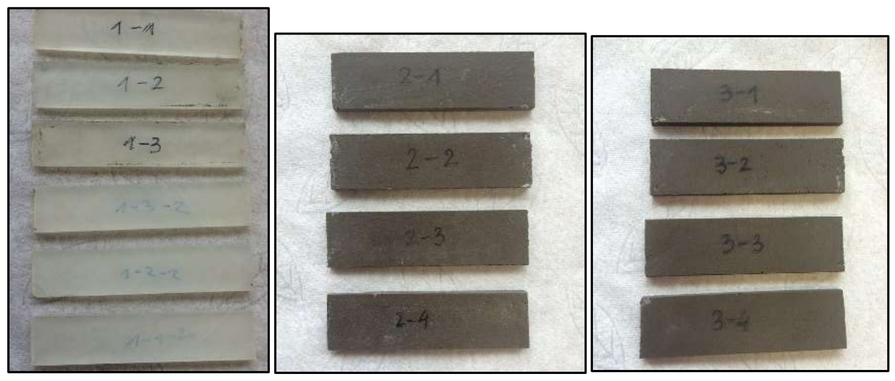
In this work, the different models of polymer composites based on fly ash as filler material in epoxy resin system were performed. The preparation of the composites was done by applying the mechanical stirrer at the room temperature. The chemical composition of the fly ash was performed with ARL PERFORM'X Sequential XRF instrument and also a particle size distribution was determined. The thermal characterization of the epoxy resin system (uncured and cured) and composites with different content of fly ash by using of Thermal Gravimetry- TG and Differential Thermal Analyses - DTA methods as well as mechanical characterization were carried out. The flexural properties of the different models of polymer composites were tested according to ISO 178 standard. It was found that presence of different content of fly ash particles have an impact on the strength of polymer composites.

Experimental

Materials

epoxy resin system

fly ash



test specimens for flexural testing

Universal testing machine ZWICK Z-100

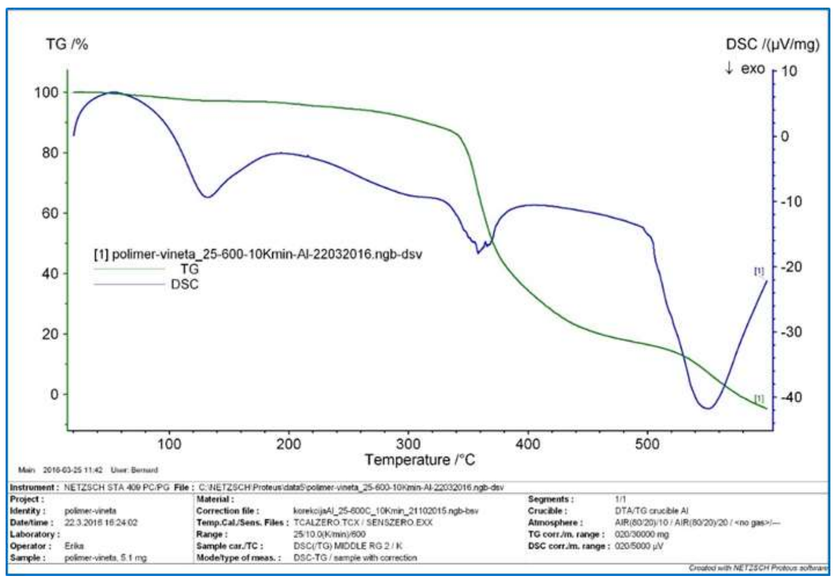
mixture systems epoxy / fly ash

ARL PERFORM'X Sequential XRF instrument

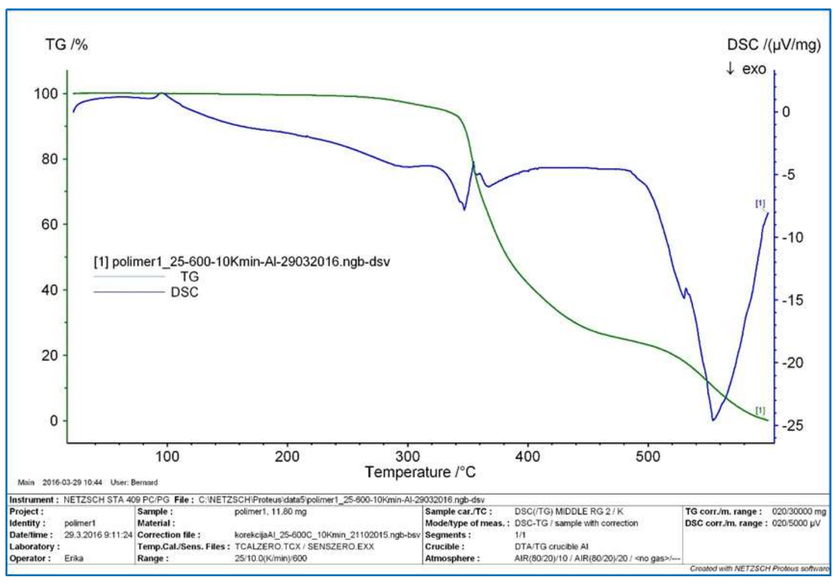
TG/DTA NETZSCH instrument

Result and discussion

Thermogravimetric curves (TGA/DSC) of an uncured epoxy resin system



TGA/DSC for cured epoxy resin system



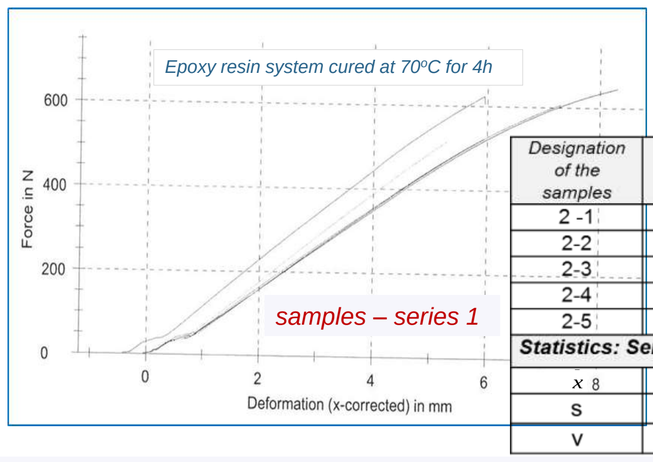
Chemical composition of the Slovenian fly ash V-333/14

Component	Content in fly ash V-333/14, %
SiO_2	39,64
Al_2O_3	17,34
Fe_2O_3	7,23
MgO	4,35
CaO	17,48
Na_2O	0
K_2O	1,63
TiO_2	0,51
LOI	5,01
P_2O_5	0,96

Particle size distribution

Particle diameter (µm)	V333/14, % mas.
0,1	0,69
0,4	2,08
0,9	2,80
1	2,88
2	4,05
6	11,33
10	18,56
12	21,49
18	28,55
20	30,61
30	39,59
40	46,52
63	58,59
90	69,39
100	72,36
125	77,84
200	85,05
250	87,91
400	95,01
500	97,10
1000	99,31
2000	99,98
4000	100,00
8000	100,00

Force and displacement curves of epoxy resin system



Designation of the samples	E_f, MPa	σ, MPa	ε, mm	ε, %
2 -1	3750	139	5,95	4,1
2-2	2380	144	7,30	4,8
2-3	2500	153	8,30	5,5
2-4	2940	119	5,31	3,6
2-5	2200	120	5,96	4,0
Statistics: Series n = 5				
$\bar{x}$ 8	2750	135	6,75	4,4
s	621	15,0	1,21	0,8
v	22,55	11,09	18,47	17,40

Force and displacement curves of composites: epoxy resin system/fly ash

Designation of the samples	E_f, MPa	σ, MPa	ε, mm	ε, %
2 -1	4060	60,9	2,11	1.4
2-2	4310	68,2	2,30	1,6
2-3	5460	75,4	2,02	1,4
2-4	5400	79,5	2,20	1,5
2-5	5490	79,2	2,18	1,5
Statistics: Series n = 5				
$\bar{x}$	4940	72,6	2,16	1,5
s	698	8,01	0,11	0,1
v	14,12	11,02	4,91	5,23

Designation of the samples	E_f, MPa	σ, MPa	ε, mm	ε, %
3 -1	6920	56,6	1,23	0,8
3-2	7240	52,7	1,09	0,8
3-3	7120	50,2	1,05	0,7
3-4	8250	50,6	0,94	0,6
3-5	7780	68,3	1,33	0,9
Statistics: Series n = 5				
$\bar{x}$	7570	53,2	1,06	0,7
s	516	7,41	0,17	0,1
v	6,81	13,92	16,27	16,24

Conclusion

From the thermal characterization of the epoxy resin system (uncured and cured) it was found that an uncured and cured epoxy resin system loses about 10% of its weight until 350 ºC, followed by ongoing 90% weight loss to 450–500 ºC. After that, the weight loss continues with a slower degradation rate. It should be noted that at a temperature of 600 ºC, the epoxy resin systems exhibit residual weight of about 8%. From the flexural properties of the different models of polymer composites it was found that presence of different content of fly ash particles have an impact on the strength of polymer composites. The polymer composites with 50 wt.% fly ash particles have the best results depending of the tested thermal end mechanical characteristics.

These investigations represent a beginning of the future research for possibilities of using the NORM into the polymer materials.