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CHANGING THE PROPERTIES OF THE COMPOSITE PA + GF TO UV RADIATION

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1.Introduction

Composite materials are composed of two or more chemically different components, of which at least one, referred to as a matrix, is continuous. The second component is dispersed in the matrix and is referred to as a filler. Hybrid composites are materials that are composed of three or more components. The hybrid matrix comprises two types of polymers, hybrid filler is composed of two or more types of fillers. Besides filler and matrix composite materials comprise a third component, referred to as the intermediate phase. The term intermediate phase is often wrongly confused with the interfacial interface. In the past, some of the additives, fillers glad, as well as additives (eg. stabilizers, flame retardants, lubricants, nucleating agents), and the fillers are added to polymers to improve their properties [1,2]. However, while the priority task additives modify the physical and processing properties of polymer (viscosity, the proportion of crystalline phase, thermal stability, etc.), addition of fillers to polymers is in particular monitor the improvement of the mechanical properties. The resulting composite is therefore compared with the original polymer matrix often vastly different physical-mechanical properties. Depending on the type of composite, the filler content varies widely. Selection of the filler and its content in the composite is always oriented to give

the maximum improvement in the desired properties. The final properties of the polymers resulting from exposure to several factors. The most important features

- physico-chemical properties of the filler (chemical composition, structure, size and particle size distribution, surface area),
- physico-chemical characteristics of the matrix (chemical structure, molecular weight, supramolecular structure),
- shape of fillers (fibrous, particulate, plates),
- filler content in the composite,
- process for the preparation of composites,
- character of interfacial interface,
- interaction at the phase interface between the polymer and the filler, a filler and a filler.

In function of the matrices for composite materials are used not only polymer but also of metal, ceramic and carbon matrix. Depending on the type of the matrix composites are therefore classified into the metallic composites, ceramic composites, carbon composites, and polymer composites. Fibrous polymer composites are the oldest and still the most widely used composite materials. The first industrial applications of fiber polymer composites based on thermosetting matrices and glass fibers were introduced in the aviation industry in the years 1930-40 [3,4].

Other important factors affecting the properties of fibrous composites include fiber orientation. The fiber orientation in the composite is critical not only in terms of the resulting properties of the application, but also the selection of appropriate treatment methodology. The above criteria are imposed on the fiber orientation, the more difficult the product technology. When sizing the resulting application properties of fibrous composites is therefore necessary to specify the which direction relative to the orientation of the fibers, the products are exposed. Depending on the orientation of the fiber polymer composites are classified into:

- composites with long unidirectional fibers,
- composites with long across the board oriented strand board (laminates),
- composites with space oriented fibers,
- composites with short non-oriented or preferably oriented fibers [4-6].

Use as fiber of polymers are used several types organic and inorganic fibers. Commercially produced glass, carbon and aramid fibers are available in wide range of properties from high strength (HS) through High modulus (HM) to ultra-high (UHS, UHM). Basic physical and strength characteristics of the fibers used for the production of polymer fiber composite are shown in Tab. 1 [7,8].

Tab. 1 *Basic characteristics of glass, carbon and aramid fibers*

Fiber type	Density [g.cm^{-3}]	Strength [MPa]	Module [GPa]	Extension [%]
glass	2.54	3450	73	3-4
carbon	1.78-1.81	3800-6530	230-400	1.78-1.81
aramid	1.44	3600-4100	131	-

2.Materials and methods

As experimental material was used composite formed polymer matrix (PA) and filler – glass fibres. Glass fibre has a production label GF 672, fibre diameter is 10 μm and fibre length is 4 mm. The test composite contains 20% glass fibre (lable PA+20GF). This is a modern material that will be used in automobile interior and exterior. The composition should be resistant to UV radiation due to the addition of UV stabilisers. All test specimens were prepared by injection molding technology.

Testing degradation of polymeric materials is one of the most important tests to the lifetime of polymer product. Ageing tests can be either in real conditions of use of the polymer in a particular application, or using artificial accelerated ageing conditions. Accelerated ageing methods provide test results significantly faster natural aging tests. Testing is based on exposing test bars to man-made climate. After a fixed interval of exposure changes are detected in end points (aesthetic, physical, electrical, etc.). The apparatus for man-made weather ageing (Fig. 1) ensure continued maintaining of artificial climatic conditions (day and night cycles, changing humidity, drought and wet, etc.)

Fig. 1 *SolarBox 1500 E with flooding*

A source of light radiation guarantees a radiant flux of radiation intensity 550 W m^{-2}. The source of light is a xenon arc lamp, but other sources of radiation are allowed

too. The device must be equipped with a thermometer built into the black panel, which senses the temperature of the black panel. The black panel temperature of exposure time was selected at 65 °C, the liquid phase lasted for 102 minutes and the wet phase for 18 minutes. If it necessary wetting by distilled or deionised water can be applied. The numbers of man-made climate factors that simultaneously affect the test bars is selected by the test program. Test runs continued for a period fixed in the testing program. The duration of the test was 500, 750 and 1000 hours.

3.Results and discussion

The test samples were evaluated by the selected mechanical parameters (tensile strength and flexural strength) regarding the effects of UV radiation. The same parameters were assessed after 3 runs (500, 750 and 1000 hours) of UV radiation acting on the sample. The test also included evaluation of the structure and changes in the structure before and after UV irradiation.

Samples for the structure test were embedded in Bakelite in the first step and then cut and polished. Grinding of the samples was carried out using the device Struers Tegra Pol-15 under a program designed for polyamides. SiC abrasive paper with grain size 500, 1 200 and 4 000 was used for grinding. Each grit sandpaper was used to grind the sample for 1 minute. Grinding was followed by polishing using Mol plate for 3 minutes. This was followed by 2 minute polishing with Nap-B, and finally polishing was finalized using wet disc and Chem-OP-S (diamond slurry) for 1 minute. The samples prepared in the above-mentioned way were evaluated for structure changes by light microscope Neophot 32.

A tensile test was performed using the device WDW 20. The speed of a moving jaw was set at 1 $mm.min^{-1}$ with. The sample was pinned to the jaw and force was exercised in the longitudinal axis until the sample break. We measured the maximum force required to break the test samples. From the acquired data, we calculated the tensile strength, σ_M (Fig. 2).

Fig. 2 shows that UV radiation slightly decreased the tensile strength. The most significant decrease in the observed values was recorded at the 750 –hour exposure to UV radiation. on values obtained at testing a specimen exposed 750 hours to UV radiation. After 1000 hours of exposure to UV radiation the tensile strength slightly increased again, which was probably due to partial cross-linking of the polymer matrix.

Fig. 2 *Effect of UV radiation on the change in tensile strength*

A bend test was also performed using the device WDW 20 with the aid of three-point bending. The sample is put on two supports placed, 40 mm away from each other. Burden was applied in the middle of the sample bar to exercise some force. Print speed was also one arm 1 mm.min^{-1}. Peak force was recorded during the test. The test results are indicated in Fig. 3.

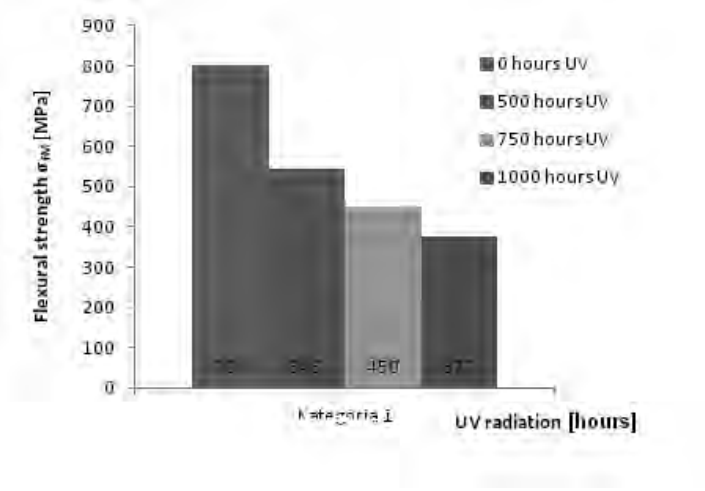
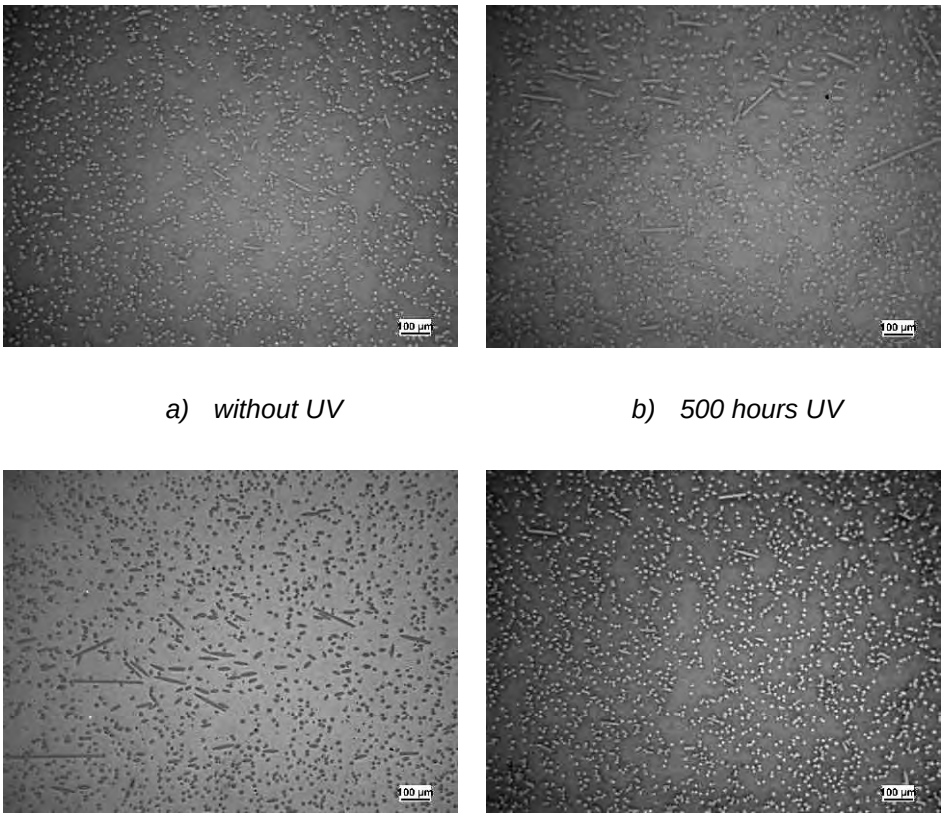


Fig. 3 *Effect of UV radiation on the change in flexural strength*

Composite specimens PC+20GF showed a significant decrease in the values of the flexural strength after the shortest-minimum period of UV irradiation (500 hours). The flexural strength decreased by more than 50 % compared to the flexural strength that was measured in samples without UV irradiation. Composites are becoming significantly

fragile. Changes in the flexural strength were considerably extensive after the longer periods (750 to 1000 hours) exposure to UV irradiation.

The experiment also included evaluation of the structure of the composite PA+10GF before and after UV irradiation by a light microscope. We monitored homogeneity of the composite, the manner of distribution of glass fibres in the polymer matrix, and cracking caused by UV radiation. On the basis of the astructure, we can conclude that the distribution of the in the matrix is uniform in the filler content of 20% (Fig. 4).

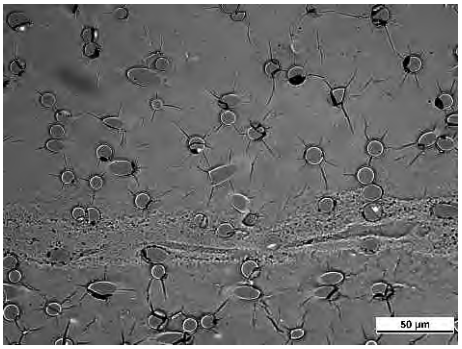


a) without UV *b) 500 hours UV*

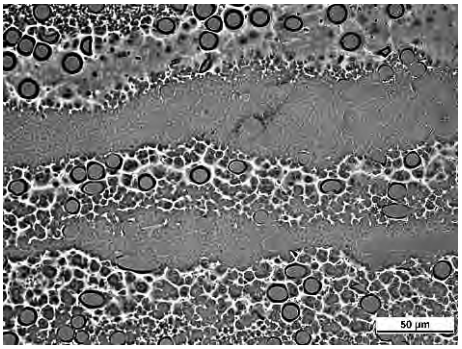
c) 750 hours UV *d) 1000 hours UV*

Fig. 4 *Distribution of the filler in the polymer matrix-middle, 100x*

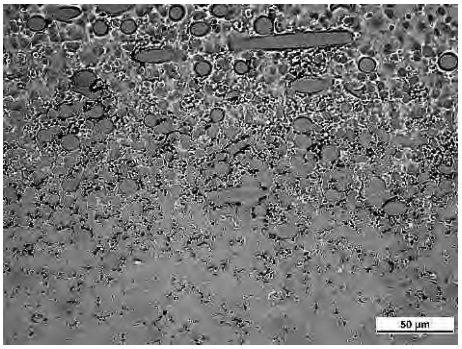
Uniform distribution of the filler in the matrix was observed in the central portion of the sample. Towards the periphery of the sample has been uneven distribution of the filler, and the density of the filler was increasing.



a) 500 UV



b) 750 UV



c) 1000 UV

Fig. 5 *The change in the matrix and the presence of cracks after UV radiation, 500x*

UV radiation is an intense degradation factors affecting the change in the structure of polymers. As can be seen in Fig. 5 even a minimum duration of UV irradiation significantly changes the nature of the observed sample areas. The polymer matrix begins to degrade by UV radiation gradually. The polymer matrix is separated from the glass fiber. The polymer matrix-fibre interface exhibits low adhesion, which is needed in the future to support the addition of the adhesive. UV radiation created cracks in the composite, which is spread in the direction of the glass fibre in the polymer matrix.

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Summary

Changing the properties of the composite PA + GF to UV radiation

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This article deals with monitoring the changes in the mechanical properties of composites with polymer matrix. The composite was formed from the PA matrix and glass fibers. The composite contains 20% glass fibers. The mechanical properties, tensile strength and flexural strength were evaluated on samples of the composite before and after UV radiation on the sample. The largest decline endpoints was recorded in 500 hours of UV exposure. Light microscopy was evaluated distribution of glass fibers in the polymer matrix and the presence of cracks caused by UV radiation.