APPLICATION OF PLASMA TREATMENT ON TEXTILE REINFORCED COMPOSITES

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Abstract
The plasma teratment was apply on diferrent types of fabrics. The fabrics from carbon, glass, kevlar and polyester were terated by surface barrier plasma discharge for 20, 40, 60s. Properties like wettability, adhesion and depth of penetration of binder (polyethylene) into the fibers were observed and compared with untreated fabric.
Key words: Plasma, composites, penetration, bond strength.

1. Introduction

The plasma modification is a new method of improvement of adhesive properties of material. This treatment has an influence on wettability of textile, can improve adhesive properties and the chemical changes in surface can be caused by plasma treatment also. In context of this, the dyeability, washing fastness and stability of other surface finishes which are based on surface properties of textile (like printing, binding an so on) are improved.

Properties of reinforced composites are based on properties of fibres inside, on polymeric resin as well as on interfaces between fibre reinforcement and the polymer. The plasma treatment is one of the possibilities how to improve the interface properties. The surface layer, which is influenced by plasma treatment, is very thin (ranges about 10 μm). Therefore properties of used polymer are not changed. This fact is important for composites reinforced by polymer fibres.

2.Experiment

The glass fabric (linen weave, 163 g/m^2), carbon fabric (linen weave, 160 g/m^2), Kevlar fabric (linen weave, 115 g/m^2) and polyester fabric (sateen weave, 220 g/m^2) were used like fibre reinforcements.

These materials were treated by plasma discharge; the plasma reactor UPR 100W with surface barrier discharge was used. The time of treatments was different (the time 20, 40, 60 seconds was tested). The normal air (at atmospheric pressure) was used like working gas. This type of plasma can produce the ketonic, aldehydic and carboxyle groups on surface layer.

Treated and untreated materials were bonded by polyethylene foil. The properties of PE-LD foil: thickness 25 μm, glass transition Tg = 50°C, melting point Tm = 110°C.

2.1 Preparation of samples

Used samples were cleaned by dichloromethane, and then plasma treatment was applied. Four samples are prepared form each material (glass, carbon, Kevlar, polyester). One scale of samples included untreated sample and samples treated for 20s, 40s, and 60s by plasma discharge.

For testing of penetration and adhesive properties the square (2x2 cm) of PE-LD foil was placed between two samples of tested fabric (2x8 cm) and put to the machine with heated clamps.

The M247A Scorch Tester machine was used to attained the melting point of foil. The working temperature was 130°C. The …. is shown at fig. 1.

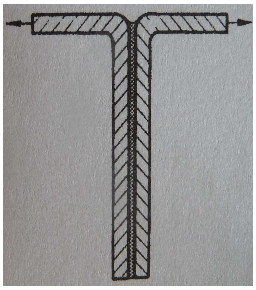

Figure 1. Form of joint for testing of adhesion by Lab Test

2.2 Testing of samples

Infrared spectroscopy was used for detection of chemical changes on surface of fibres. Treated and untreated samples were tested by this method. Results are summarised in chap. 3. The penetration of polyethylene into fabric was observed by *scanning electron microscopy*. This method provides information about homogeneity and depth of penetration into fabric.
Adhesive properties of binder (polyethylene) were tested by *Lab Test*. All measuring proceed 5 times and the average values of strength, extensibility and strain work are presented here.

3 Results

3.1 Infrared spestroscopy

The surface of untreat samples and samples which was treated by plasma for 40s were tested by infrared spectroscopy. The aim of this testing was evaluation of chemical changes at surface of fabric reinforcement. This analysis shows, that chemical structure of surface was not significantly changed.

3.2 Penetration of polyethylene into fabric

Samples, which were prepared by method described in 2.2, were cut and observed by the help of scanning electron microscopy. This testing was used for all samples. The most interesting photos are shown at fig. 2 - 6. Generally, the plasma treatment provides better penetration into fabric. The layer of polyethylene binder is more homogenous and depth of penetration is higher also.

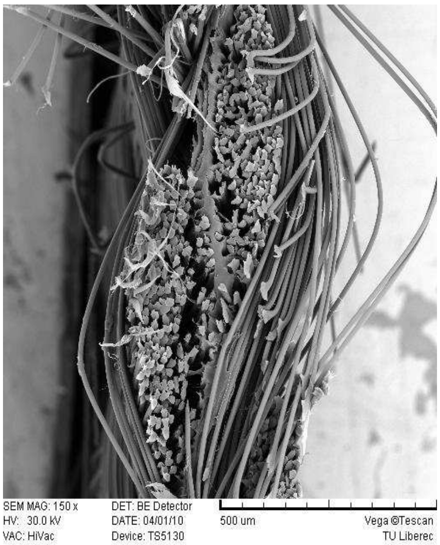

Figure 2. Untreated Kevlar fabrics bonded by polyethylene foil

Figure 3. Kevlar fabrics treated by plasma for 40s bonded by polyethylene foil

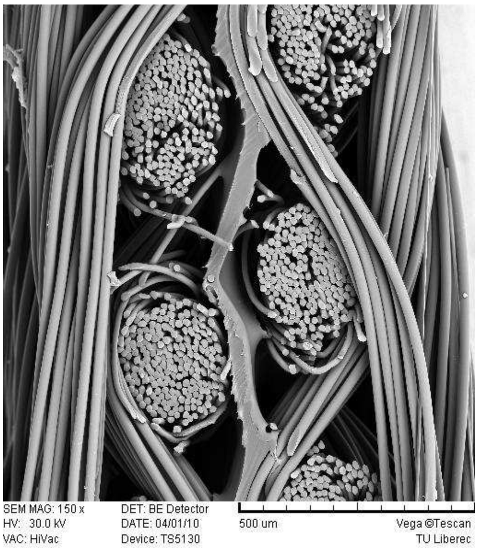

Figure 4. Untreated polyester fabrics bonded by polyethylene foil

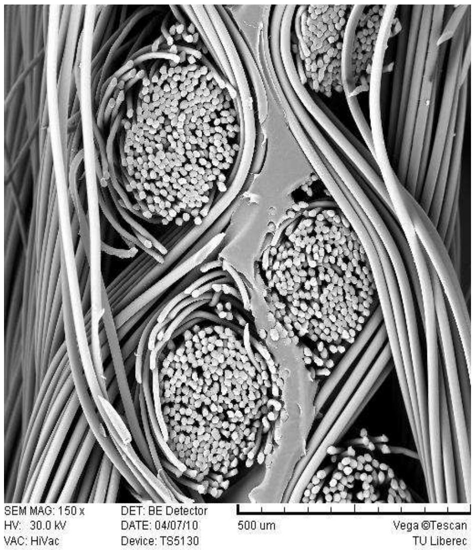

Figure 5. Polyester fabrics treated by plasma for 20s bonded by polyethylene foil

3.3 Strength, extensibility and strain work

The strength, extensibility and strain work was tested by Lab Test. Figures 6 - 8 show the dependence of strength on duration of plasma treatment. The untreated sample is descibed like zero value, other samples are described in context of duration of plasma treatment (20 means 20s, 40 means 40s and 60 is 60s).

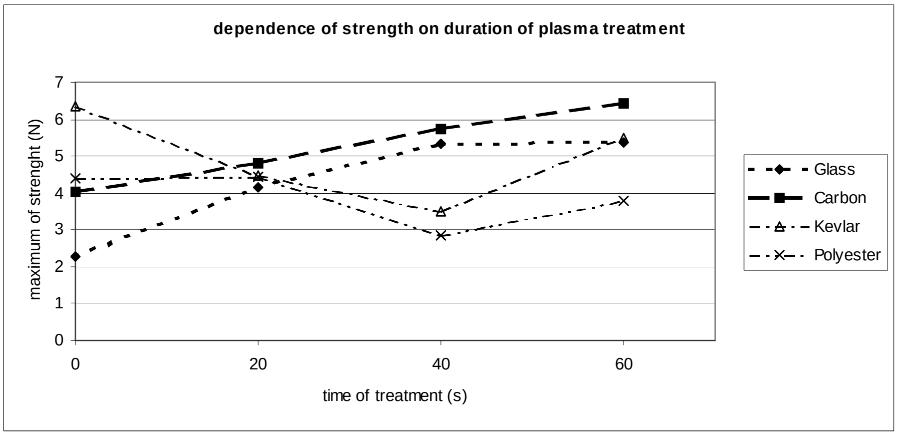

Figure 6. Dependence of strength on duration of plasma treatment

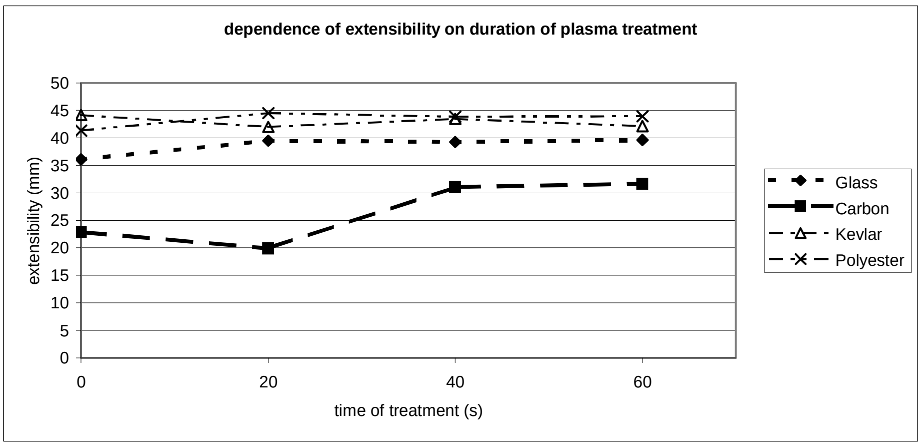

Figure 7. Dependence of extensibility on duration of plasma treatment

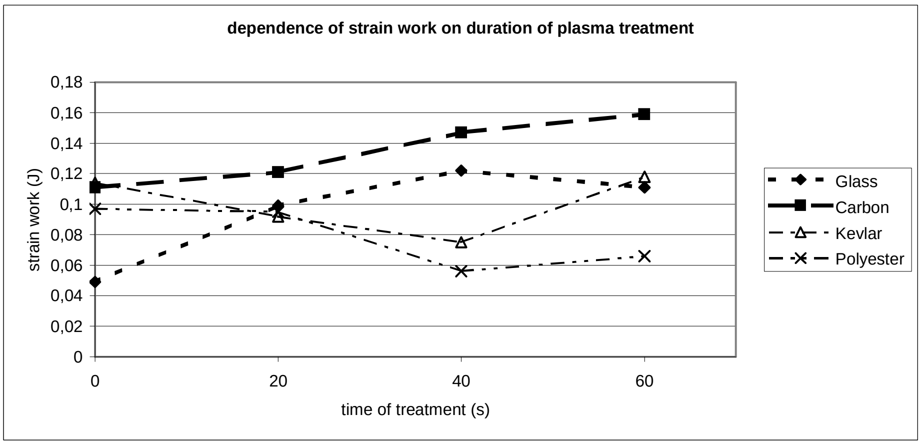

Figure 8. Dependence of strain work on duration of plasma treatment

4. Conclusion

We can say, that our tests showed the influence of plasma treatment on adhesive properties of fabric reinforcements. Figures 2 – 5 show that samples with plasma treatment have more homogenous structure than untreated samples. The testing of adhesive properties show that, strength is higher in case of glass and carbon samples when the plasma is used. The strength is lower for treated polyester and Kevlar.

It is clear, that surface (properties of surface) is changed by plasma treatment. But the essence of this still is not clear still. The infrared spectroscopy did not show significant changes at surface, but this method works with surface layer, which is thicker than surface layer, which is influenced by plasma.

5. References

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