MECHANICAL AND THERMAL PROPERTIES OF DOPE DYED P-ARAMID FABRIC/SURLYN COMPOSITES

Yeongmi Kim[1], Jinwon Cho[1,*], Jongdeok Choe[1], Jaewoong Lee[2] and Hyunseok Lee[3], Heebun Kwon[3]

[1]Shin Heung, 86-55, 1 Gongdan-ro, Gumi-si, Gyeongsangbuk-do, South Korea
Email: ymkim@monotex.com, Web Page: http://www.monotex.com
[2]Department of Fiber System Engineering & Technology, Yeungnam University, Gyeongsan, Gyungbuk, 38541, South Korea
Email: jaewlee@yu.ac.kr, Web Page: http://www.yu.ac.kr
[3]Korea Textile Debelopment Institute, 136 Gukchaebosangro, Seo-gu, Daegu, South Korea
Email: hslee@textile.or.kr, Web Page: http://super.textopia.or.kr
[*]Corresponding author (E-mail: screenpd@monotex.com)

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Abstract
Thermosetting resin prepreg is disadvantageous to expensive and difficult to use in living goods and electronic devices. In the case of thermoplastic prepreg marketability is made for living goods and electronic devices. P-aramid fiber is bulletproof material. Recently, P-aramid fibers have been applied to various fields. Dope dyed p-aramid was developed, it was able to maintain mechanical properties and emphasize the aesthetic characteristics. Surlyn are not applied to composite materials. This resin has low mechanical properties, but high scratch resistance and gloss. In this study, dope dyed p-aramid fabric/surlyn composites were fabricated by using a compression molding method. We used dope dyed p-aramid fiber instead of generally p-aramid of yellow. Surlyn used was grade with excellent melt-index. The contents of dope dyed P-aramid fabric and surlyn in the composites were 60 % by weight, respectively. Two different types of 400D dope dyed P-aramid fabric and 1500D dope dyed P-aramid fabric, respectively, were utilized for making composites. Dope dyed P-aramid fabric was woven in a dobby pattern. To understand 400D dope dyed P-aramid fabric/surlyn composites and 1500D dope dyed P-aramid fabric/surlyn composites, the thermal stability, tensile, flexural, glossiness properties were extensively characterized and compared.

1. Introduction

Recently, consumers pursuing beauty has increased. Because of that, living goods and electronic devices are beautiful design are demanded. Interest in composite materials is rising to make beautiful and durable products. Generally, composite materials use thermosetting resins. But, thermosetting resin prepreg is disadvantageous to expensive and difficult to use in living goods and electronic devices. In the case of thermoplastic prepreg marketability is made for living goods and electronic devices.

Composite materials uses carbon fiber or glass fiber as a reinforcement. Carbon fiber has high mechanical properties [1]. But this is expensive. Glass fiber is cheap, but has lower mechanical properties than carbon fiber. Also, carbon fiber color is only black and glass fiber color is only white. Therfore, carbon fiber and glass fiber have limitations in showing aesthetic characteristics.

Most recently, a large number of papers deal with p-aramid fiber and fabric [2]. P-aramid fiber can be used as bulletproof material. Generally, p-aramid fiber color is yellow. Yellow P-aramid fiber has

higher mechanical properties than glass fiber and lower cost than carbon fiber. But, yellow p-aramid fiber has limit to show aesthetic characteristics. So, dope dyed p-aramid is use for increase to aesthetic characteristics. Dope dyed p-aramid was able to maintain mechanical properties and emphasize the aesthetic characteristics.

Consequently, the objective of the study is maintain mechanical properties and to increase the aesthetic characteristics by incorporationg dope dyed p-aramid fabric into surlyn.

2. Experimental

2.1. Material

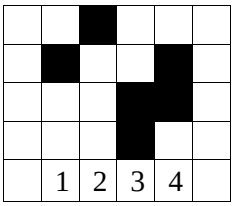
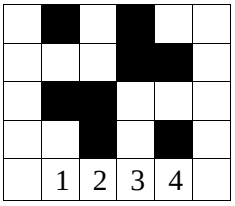
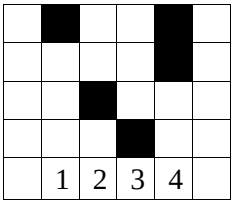
Dope dyed P-aramid fabric used in this work. P-aramid fiber was purchased from Dupont, consisted of 1500 deniers and 400 deniers. Weaving was performed at the our company. Surlyn(8150) a thermoplastic was purchased from Dupont. The melting temperature was 85°C.

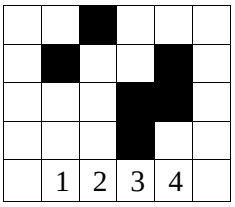
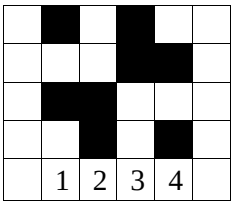
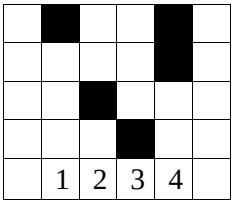
2.2. Composite Fabrication

Dope dyed P-aramid fabric/Surlyn composites with the dope dyed P-aramid content of 60% by weight were fabricatied by a film stacking and compression molding method. Sulyn films were prepared and used for stacking with dope dyed P-aramid fabric placed between the films. The dimensions of resulting dope dyed P-aramid fabric/surlyn composites were 297mm × 210mm × 3mm. The molding temperature was 230°C for successful melting of Sulyn films. And then, the molding pressure of 10 psi.

Composite materials were classified depending on fiber denier and fabric design. 1500D dope dyed p-aramid fabric is specified as 60, 62, 64 depending on the fabric design and 400D dope dyed p-aramid fabric as 150, 151, 152. Fabric designs are 60 and 150, 62 and 151, 64 and 152 are the same.

Table 1. Dope dyed p-aramid fabric design

Denier	Number	Design	Warp (ends/inch)	Weft (ends/inch)
1500	60		19	19
	62		19	19
	64		19	19

400	150		37	37
	151		37	37
	152		37	37

2.3. Caracterization

Fabric tensile tests were pereformed with dope dyed P-aramid fabric according to KS K 0521. The experiment was carried out by the strip method. The width of 50mm was used and crossheqd speed was 50mm/min.

Thermal Stability tests was performed with dope dyed P-aramid fabric/surlyn composites according to KS M 3071. The test conditons was maintained at (60 ± 2)℃ for 6 hours.

Three-point flexural tests were performed with dope dyed P-aramid fabric/surlyn composites according to ASTM D790. The span-to-depth ratio was 16:1. The load cell of 50kN was used and the crosshead speed was 1.5mm/min. Five Specimens were measured and the averaged flexural strength and modulus were obtained.

The Glossniess tests were performed with dope dyed P-aramid fabric/surlyn composites according to KS M ISO 2813. The measurement angle was 60˚.

2.4. Results

Figure 1 shows the tensile strength of 1500D dope dyed p-aramid fabric and 400D dope dyed p-aramid fabric. As can be seen, 1500D dope dyed p-aramid fabric has a higher tensile strength than 400D dope dyed p-aramid fabric. But, tensile strength showed no significant change depending on the fabric design.

Table 2 shows the composite materials was measured for termal stability at (60 ± 2)℃ for 6 hours, powdering, cracking and deformation did not occur. Therefore, dope dyed p-aramid fabric/surlyn composite can be said to be thermally stable.

Figure 2 and Figure 3 shows the flexural strength and modulus of 1500D dope dyed p-aramid fabric/surlyn composites and 400D dope dyed p-aramid fabric/surlyn composites. 1500D dope dyed p-aramid fabric/surlyn composites has a lower flexural strength than 400D dope dyed p-aramid fabric.

Flexural modulus of 1500D dope dyed p-aramid fabric/surlyn composites shows the similar flexural modulus to the 400D dope dyed p-aramid fabric/surlyn composites.

Table 3 shows the glossiness of the composite materials. Glossiness of the composite material showed a minimum value of 96.9% and a maximum value of 102.9%. Overall, it has high glossiness.

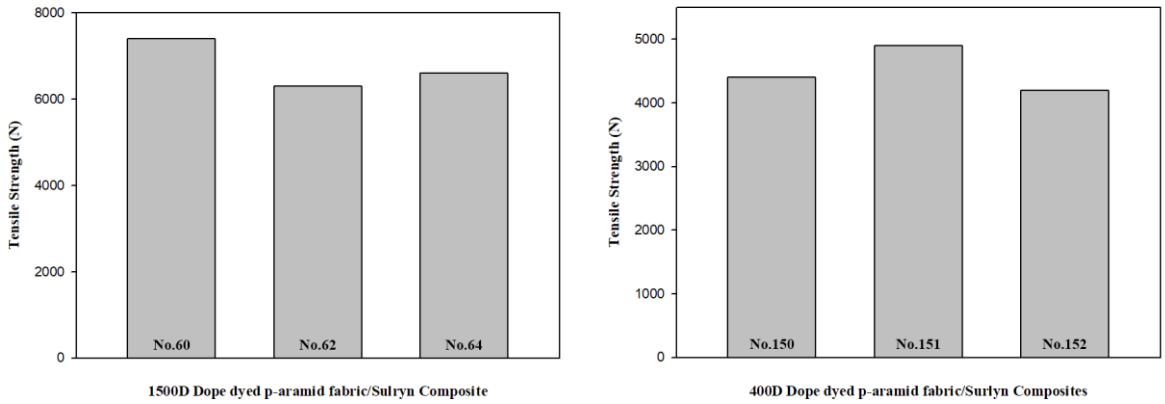


Figure 1. Tensile strength of 1500D dope dyed p-aramid fabric and 400D dope dyed p-aramid fabric.

Table 2. Thermal stability of dope dyed p-aramid fabric/surlyn composites.

Specimen Type	Specimen condition		
	powdering	cracking	deformation
60	Pass	Pass	Pass
62	Pass	Pass	Pass
64	Pass	Pass	Pass
150	Pass	Pass	Pass
151	Pass	Pass	Pass
152	Pass	Pass	Pass

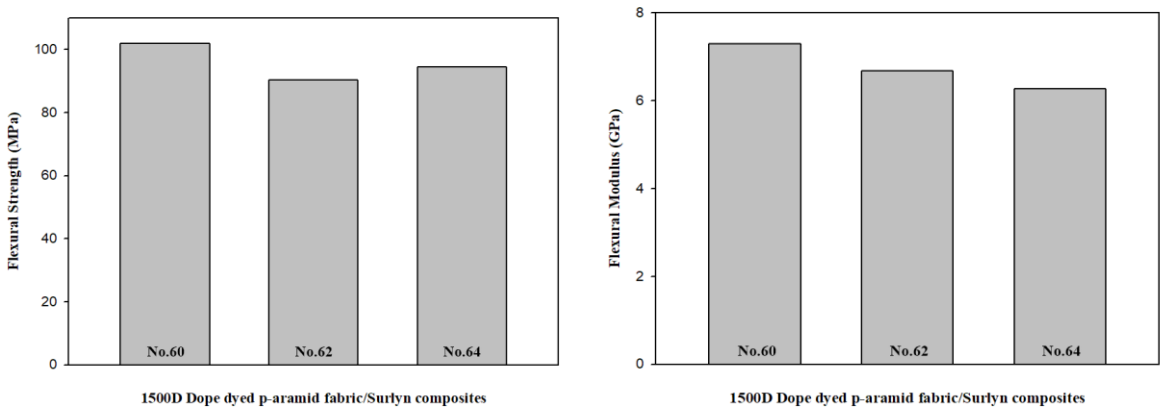


Figure 2. Flexural strength and modulus of 1500D dope dyed p-aramid fabric/surlyn composites.

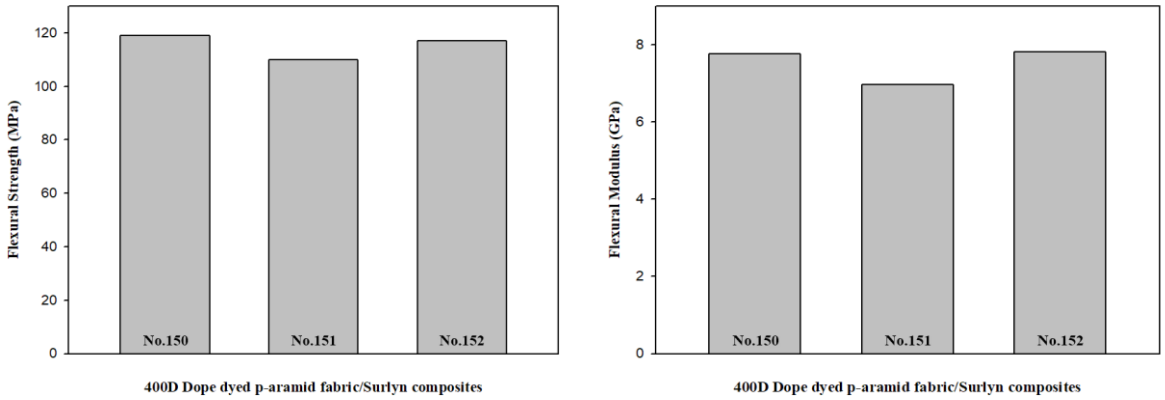


Figure 3. Flexural strength and modulus of 400D dope dyed p-aramid fabric/surlyn composites.

Table 3. Glossiness of dope dyed p-aramid fabric/surlyn composites.

Specimen Type	60	62	64	150	151	152
Glossiness (%)	100.3	100.3	96.9	102.9	101.2	101.8

3. Conclusions

1500D dope dyed p-aramid fabric has a higher tensile strength than 400D dope dyed p-aramid fabric. But, 1500D dope dyed p-aramid fabric/surlyn composites has a lower flexural strength than 400D dope dyed p-aramid fabric. Flexural modulus of 1500D dope dyed p-aramid fabric/surlyn composites shows the similar flexural modulus to the 400D dope dyed p-aramid fabric/surlyn composites. In thermal stability and glossiness, both 1500D dope dyed p-aramid fabric/surlyn composites and 400D dope dyed p-aramid fabric/surlyn composites showed good properties.

As a result of analysis, it was confirmed that the thermal and mechanical properties did not change significantly depending on the fiber denier and the fabric design. Therefore, any of 1500D dope dyed p-aramid fabric and 400D dope dyed p-aramid fabric may be used. And the use of dope dyed p-aramid fabric can increase the aesthetic characteristic of the composite materials and satisfy the consumers.

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References

[1] P. Morgan. *Carbon fibers and their composites.* CRC Press Taylor & Francis Group, 2005.

[2] G.V.Seretis, P.K.Kostazos, D.E.Manolakos and C.G.Provatidis. On the mechanical response of woven para-aramid protection fabrics. *Composite Part B: Engineerin*g, Volume 19, 67-73, 2015.