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# Adhesion properties between CR(Chloroprene rubber) and plasma treated aramid fiber

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## 1. INTRODUCTION

Aramid fiber has been widely used as the reinforcement of composites due to its high modulus and strength. However relatively smooth surface of the fiber limited its use in the fiber reinforced composite. Especially, good adhesion of aramid fiber to the rubber matrix is very difficult because of mismatch of their surface properties. Therefore, fiber surface should be modified to improve its properties suitable for the composite applications. One of the surface modification methods, oxygen plasma treatment is especially effective and environmentally friendly process. Oxygen and oxygen-containing plasmas are developed to improve fiber surface modification.

Chloroprene rubber has high modulus, abrasion resistance, weather resistance, and thus it has been applied to the automobile hose, tire splicing yarn and cable coating etc.

The purpose of this work is to study the surface modification of aramid fiber by oxygen plasma treatment and investigate the interfacial adhesion between CR and plasma treated aramid fiber.

## 2. EXPERIMENTALS

2.1 Materials

Aramid fiber used in this experiment was Twaron T750 (Teijin) having average diameter of 12㎛. Matrix was chloroprene rubber supplied from Daeryuk chemical company, Korea. The experimental procedures is illustrated in Figure 1.

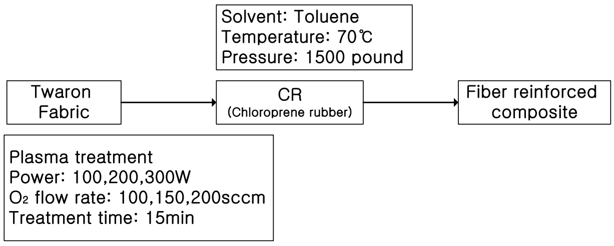



Figure 1. Experimental procedure of aramid/CR compsoites

2.2 Plasma treatment

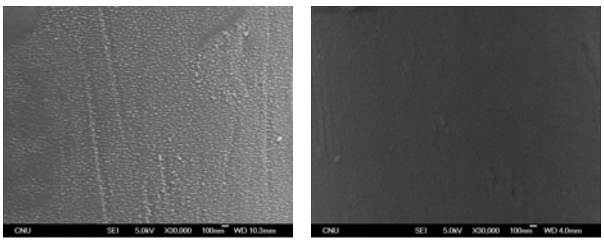
The plasma was activated by an parallel plate radio frequency generator. Oxygen gas was fed into the vacuum chamber at the various flow rate of 100sccm, 150sccm, and 200sccm. Oxygen plasma was emitted for 15min with a power of 100W, 200W and 300W.

2.3 Characterizations

The fibers were coated with gold to be placed on the cell so that observed using a SEM (JEOL, JSM-7000F). The XPS (Thermo, MultiLab) was used to determine the surface chemical composition of aramid fibers before/after plasma treatment. The dynamic contact angle (DCA) was measured by K100SF (KRUSS) measurement system according to the Wilhelmy method. The aramid fibe was cut into 1cm length to be fixed on the holder. The cut fiber was sent into two types of liquid, distilled water (surface tension 72.75mN/m) and formamide (surface tension 58.2mN/m). The cross-head speed was 3mm/min. The surface tension ( $\gamma$ ) of the fiber was calculated from a combination of the dispersive and non-dispersive components of the surface tension. The interfacial shear strength(IFSS) of aramid fiber/chloroprene rubber was defined by the measured pull-out force from a micro-droplet test. The a micro-droplet specimen was tested by an Instron 4467 tester with a cross-head speed of 1 mm/min. A T-peel test was performed to figure out adhesive strength of the aramid/CR composites. The specimen was prepared to refer ASTM D 1876-01 and a peel rate of 5 mm/min was used.

## 3. RESULTS AND DISCUSSION

The SEM images of modified surface of aramid fiber are shown in Figure 2. Compare to the surface of untreated fiber, plasma treated fiber has micro-pits or micro-craters since plasma etching of aramid surface created them on the surface. It is found that the surface carbon concentrations of the untreated and treated fiber with plasma-power 100W, 200W and 300W are 80.4, 69.29, 60.57 and 64.05%, respectively. However, the surface oxygen concentration of the fibers, is gradually increased from 12.81 to 27.18% by plasma treatment. This indicates that oxygen plasma treatment can introduce a large amount of oxygen atoms on the fiber surface.



(a) Plasma treated fiber (b) Untreated fiber

Figure 2. SEM images of aramid fiber

In the results of the dynamic contact angle measurements, the angle of plasma-treated fiber is 55° in distilled water and 35° in formamide, while untreated one has the angle of 78° in distilled water and 50° in formamide. The calculated surface energy of untreated and plasma treated fiber are 37.17mJ/$m^2$ and 55.86 mJ/$m^2$, respectively. Improved surface wetability of aramid fibers is explained by the facts of new functional groups on the fiber surface and surface etching effect by oxygen plasma treatment.

In the IFSS results of aramid fiber reinforced CR composite by the micro-droplet test, the IFSS of plasma-treated aramid fibers/CR composite was improved by 16%. In the T-peel test, peel strength is more improved by 45% than the untreated fiber.

## 4. CONCLUSION

The effectiveness with oxygen plasma treatment of surface modification of aramid fiber was studied to apply for fiber reinforced composites. XPS analysis defined newly generated functional group on the fiber surface by oxygen plasma treatment. Surface roughness of the plasma modified aramid fiber increased mechanical interlocking between the fiber surface and matrix.

Consequently the oxygen plasma treatment is able to improve the adhesion between the aramid fiber/CR matrix through excited functional groups and etching effect on the fiber surface.

## 5. REFERENCES

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