

19. Characterization and effect of atmospheric corona plasma on grey knit polyester fabric

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Characterization and effect of atmospheric corona plasma on grey knit polyester fabric

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Abstract. The use of chemical compounds in dyeing is still dominant. This results in the redundant use of water for the washing. Therefore, there needs to be a research on an alternative method. This research is aimed at understanding the effect of both positive and negative corona plasma irradiations on fabric. It is expected that characteristics of voltage, current, and electrode spacing, as well as ion mobility from the corona plasma will be known, both for with and without grey polyester knit fabric. Other than that, dampness characteristics of the grey polyester knit fabric will also be known. Plasma discharge is generated using point-plane electrode configuration connected to a high voltage DC power supply. The number of point electrodes is 100. Meanwhile, irradiation on the fabric is performed by putting the grey polyester knit on top of the plane electrode. Characterization was then carried out by varying the voltage, spacing of both point and plane electrodes, with and without the fabric. Other than that, variation was also made for the duration of grey polyester knit fabric irradiation. The next step was water drop test to observe 1 mL water absorption on the grey polyester knit. Results show that adding potential difference increases the current of corona spark plasma discharge for both positive and negative current corona discharges. The same case was also observed when the plasma discharge was irradiated on the plane electrode, either with or without the grey polyester knit fabric. The presence of grey polyester knit altered discharge mobility in that the small spacing of the fabric increases mobility for both negative and positive corona discharge. Hence, the further the electrodes spacing, the less mobile charge particles become. Results of water drop test show that longer irradiation on the fabric speeds up water absorption in the grey polyester knit fabric, both for positive and negative corona irradiations.

1. Introduction

Turning raw fabric into ready to use cloth is the definition of textile perfecting technology. This process involves spinning, weaving, dyeing, perfecting, and making clothes. Perfecting is a process to obtain special properties that the fabric can be comfortably worn. There are many treatments performed to obtain special properties of fabric and make it comfortable to wear. One of the parameters for comfortable fabric is humidity¹.

Newly spun textile cannot absorb water as it still contains wax and other chemicals. This is why treatment against water resisting fabric is the most exclusive until today. However, this process requires the use of lots of water and chemical substances that it creates problem to the environment² especially when the material processed is synthetic.



Synthetic textile that is commonly used is polyester. Polyester is one of the fibers serving as modification object using plasma technology. Polyester is advantageous in terms of strength, anti-wrinkle, and resistant to many chemicals. Nonetheless, polyester does have the hydrophobic property, which means low absorption and adhesion that makes it less comfortable to wear. These drawbacks can be improved by among others, using plasma technology with corona plasma discharge in atmospheric condition¹.

Polyester contains very little hydrophilic cluster that it belongs to the hydrophobic fiber and in normal condition it is capable of moisture regain of only 0.4%. The use of Glow Discharge Plasma irradiation for 20 minutes results in lower polyester mass and fiber strength of 0.6% and 19.2%, respectively. Testing for lower cloth mass is aimed at figuring out the extent of fiber area scraped by the plasma energy. Lower strength is aimed at figuring out the scale of fiber damage caused by the plasma energy. SEM testing is used to confirm the bond between fiber and monomer².

The use of corona plasma discharge irradiation method against polyester results in improved polymer hydrophilic properties, especially in terms of composite material strength.^{3,4} This paper discusses alteration of physical properties of Grey knit polyester fabric due to plasma treatment aimed at improving its hydrophilic property. The type of plasma used in this research is corona plasma discharge of positive and negative currents using point-plane electrode configuration. It is then applied to Grey knit polyester fabric.

2. Research Methods

This research employed the point-plane electrode geometry. The active electrode was the point. There were 100 point electrodes used, each spaced 1.3 cm apart. Generation of negative corona discharge is shown in Figure 1, in which the anode uses metal of the same plane used as polyester sample holder and the point electrode serves as the cathode. On the other hand, to generate positive corona discharge, the point electrode serves as the anode and the plane electrode acts as the cathode.

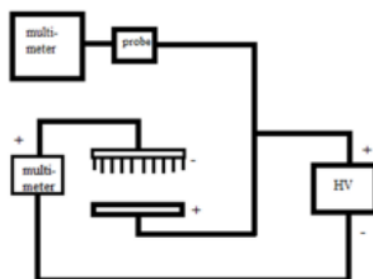


Figure 1. Scheme of research instrument circuit for negative corona irradiation.

Electrodes were connected to high DC voltage power supply. Current was measured using SANWA Multimeter Type YX-380 R connected in series to the circuit. Potential difference was measured using WENS Digital Multimeter 700S No. 6945015, which comes with 1000 V overload protection (either DC or AC) at frequencies of 5 Hz - 1.3 GHz. For this potential difference measurement, electric current was drawn from a circuit connected to the HV Probe of EnG1010 type. This HV Probe functions to convert 1000 V into 1V.

Once the instrument circuit was set, discharge characterization followed suit. It was carried out by increasing potential difference to the circuit. Observations were made on both the electric current shown by the SANWA Multimeter Type YX-380R or potential difference indicated by WENS Digital Multimeter 700S No. 6945015. Characterization was then repeated for different electrode spacings. It was then repeated again with the cloth on the anode. Characterization stages were similar to that without the cloth.

Once finished, the cloth was irradiated. The fabric used in this research was Grey polyester cloth. Potential difference and electric current were maintained at constant values during irradiation. The variations made were irradiation duration and electrode spacing.

Twenty-four (24) hours after irradiation using both negative and positive corona plasma discharge, the cloth underwent water drop test to reveal its water absorption behavior. This test was carried out by dropping 1 ml of water onto the sample cloth using a burette 1 cm off the cloth. Observations were made by recording the time it takes for the water to be absorbed by the sample cloth. The SEM method was then used to find out morphological changes.

3. Discussion and results

Figures 2(a) and 2(b) show current (I) and potential difference (V) characteristics with varied electrodes spacing for both positive and negative corona plasma discharge in sequence. In general, more potential difference increases electrical discharge current. This means that the addition of more potential difference adds more charged particles. Formation of this charged particles is possible with ionization in which in atmospheric condition is dominated by N_2^+ particles.⁵ The higher the potential difference, the more the particles act as unipolar saturation current.

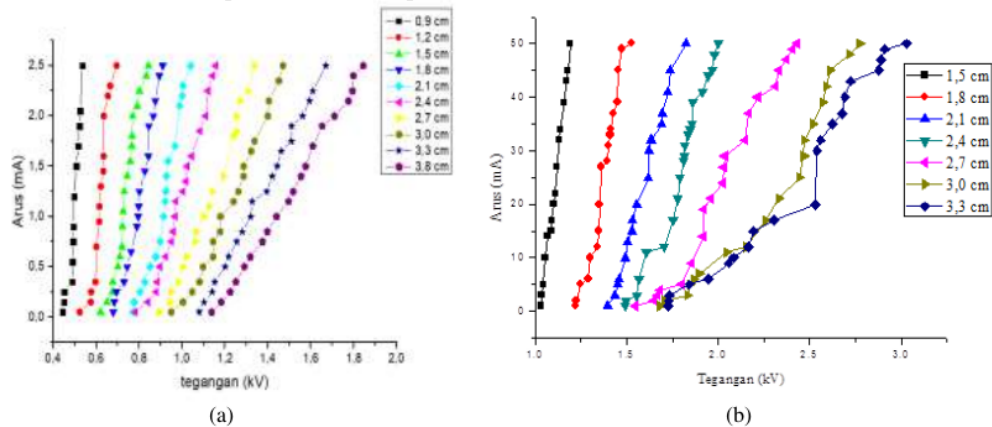


Figure 2. Characterization of corona plasma discharge, current (I) and potential difference (V); (a) positive, and (b) negative

Formation of charged particles is also due to electron capture, as in the formation of O_2^- . This happens as oxygen is an electro-negative charge.⁶ Other than O_2^- particle, the current formed by negative corona plasma discharge is also caused by electron particle. This makes the current formed during negative corona plasma discharge to be higher during positive corona plasma discharge as shown in Figure 2(b).

More electrodes spacing results in more potential difference required to generate electrical discharge. The reason is that more distance reduces potential difference. In turn, it results in less force experienced by electrons impacting gas particles in the electrical field. Therefore, higher potential difference than ionization energy is required to generate discharge. Moreover, more electrodes spacing also results in smoother graphical slope.

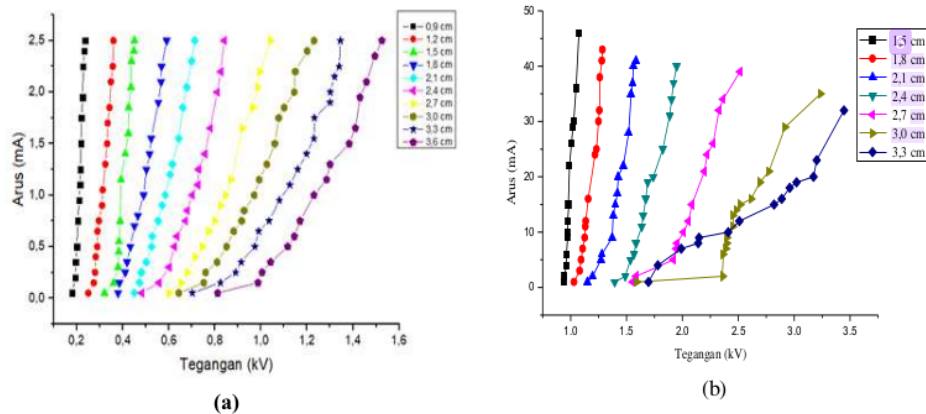


Figure 3. Characterization of positive current corona plasma discharge, current (I) and potential difference (V), with sample of Grey knit polyester fabric; (a) positive, and (b) negative

Figure 3 shows current (I) and potential difference (V) of positive and negative corona plasma discharge current with Grey knit polyester fabric put on the plane electrode. There no significant difference in patterns between matching discharge from Figure 2 and Figure 3. The only change is a shift to the left on the graph shown in Figure 3 compared to the one shown in Figure 2. This means that the Grey knit polyester fabric facilitate the generation of corona plasma in atmospheric condition, both the positive and the negative one. This result is in line with that of Susan et al.⁷ (the effect of fabric on positive corona plasma discharge) and Muhlisin et al.⁷⁸ (the effect of fabric on negative corona plasma discharge) which show that Grey knit polyester fabric increases corona plasma discharge current.

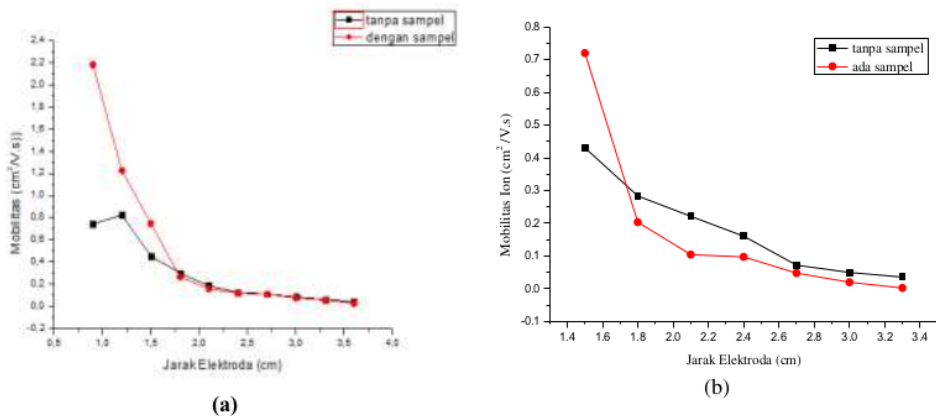


Figure 4. Mean mobility of plasma reactor charge bearer as functions of electrode spacing for (a) positive corona plasma discharge, and (b) negative corona plasma discharge.

The existence of Grey knit polyester fabric also alters the mobility of charged particles in corona plasma discharge, both positive and negative as shown Figure 4. For electrodes spacing of less than 1.6 cm, the existence of Grey knit polyester fabric increase charged particle mobility. This fact is in contrast to electrodes spacing of more than 1.6 cm that tends to reduce charged particle mobility. Reduced mobility in this case is because the Grey knit polyester fabric serves is dielectric that lowers electrical field in discharge area.

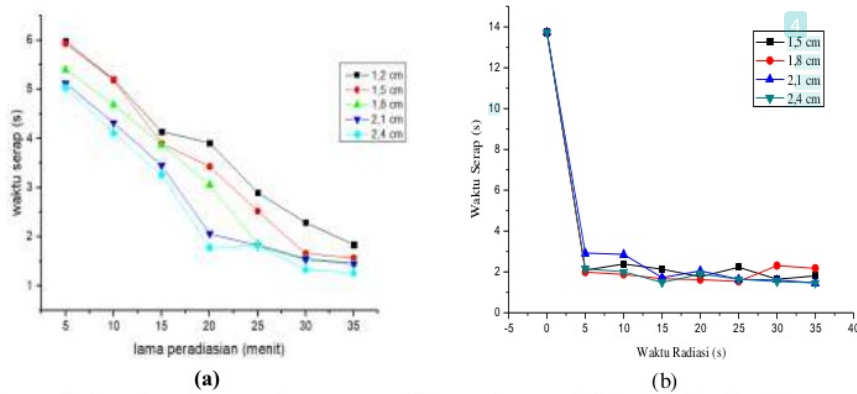


Figure 5. Results of water drop test on Grey polyester fabric irradiated with corona plasma discharge; (a) positive and (b) negative, at varied spacing.

Plasma radiation in atmospheric condition on Grey knit polyester fabric alters the timing of water absorbency as shown in Figure 5, which depicts water absorbency of 1 ml by both irradiated and non-irradiated Grey knit polyester fabric. Change in time is less water absorption time for both positive and negative corona plasma discharge irradiation. Gradual absorption time reduction takes place for the fabric irradiated with positive discharge, in which longer irradiation time results in less water absorption time. This is because corona plasma discharge irradiation, which is dominated by N_2^+ particle, on Grey knit polyester causes scratches that widen contact area with water, as shown in Figure 6(b). The longer irradiation time, the more scratches on each thread, and the result is faster absorption time.⁸

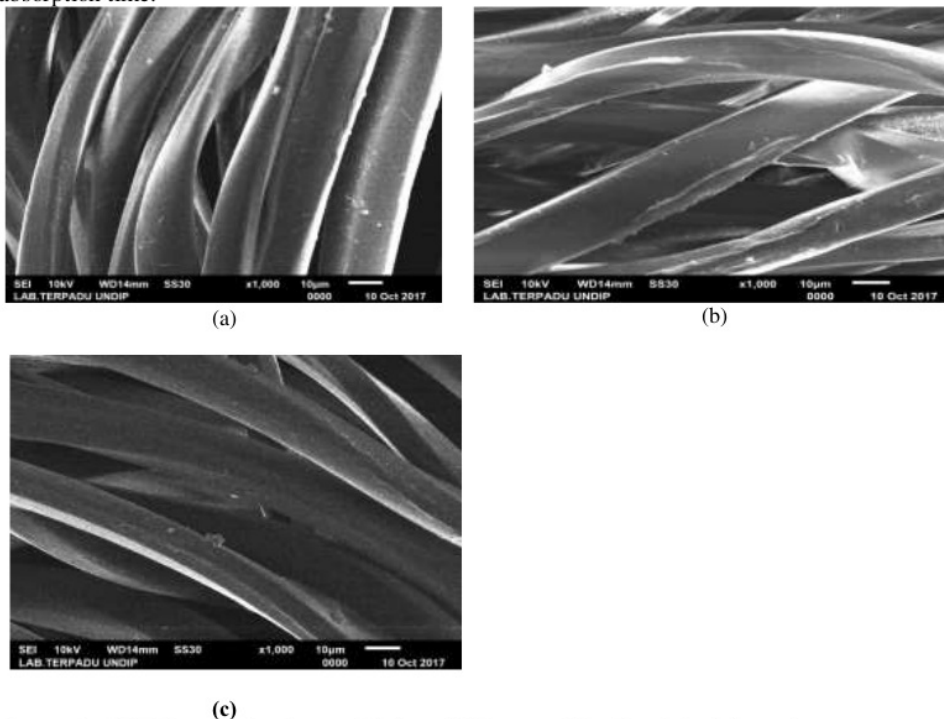


Figure 6. SEM image of polyester fabric at 1000x magnification, (a) without plasma treatment, (b) with positive corona plasma irradiation for 20 minutes with electrodes spaced 1.2 cm apart,

and (c) with negative corona plasma irradiation for 20 minutes with electrodes spaced 2.4 cm apart.

The irradiated fabric using negative corona plasma discharge shortens absorption time markedly, from 14 second to 2 -3 seconds. Irradiation of negative corona plasma discharge of up to tens of milliampere, which means more negatively charged particles impacting the fabric, as shown in Figure 6(c), reveals blisters on the threads. These blisters ease water absorption.

4. Conclusion

The existence of Grey knit polyester fabric increases discharge current, both for positive and negative corona plasma discharge. It is also found that electrodes spacing of less than 1.6 cm increases charged particle mobility, whereas electrodes spacing of more than 1.6 cm reduces charged particle mobility, irradiation of corona plasma discharge on Grey knit polyester fabric reduces water absorption time and alters its surface make up.

Reference

- [1] Kan CW, Lam YL. 2013. *Materials (Basel)*. **6** (1) 314-333.
- [2] Canbolat S, Kilinc M, Kut D. 2015. *Procedia-Soc Behav Sci*. **195** 2143-2151.
- [3] Xu W, Liu X. 2003. *Eur Polym J*. **39** (1) 199-202.
- [4] Susan, A.I., Sjaifudin, A., Widodo M., and Nur M. 2016. *Arena Tekst*. **31** (1) 11-16.
- [5] Staack D, Farouk B, Gutsol A, Fridman A. 2008. *Plasma Sources Sci Technol*. **17** (2) 25013.
- [6] Fridman A (Drexel U. 2008. *Plasma Chemistry*.
- [7] Muhlisin Z, Prastiwi D, Darliawati H, et al. *Pembangkitan Lucutan Pijar Korona Negatif Pada Kondisi Atmosfer Dan Pengaruhna Terhadap Resapan Air Pada Kain Katun Dan Poliester Grey*.
- [8] Susan, A.I., Widodo M., dan Nur M. 2017. *IOP Conf Ser Mater Sci Eng*. **214**.

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