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FAKULTA TEXTILNÍ

Plasma Treatment Of Textile Fabrics

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AUTOREFERÁT DISERTAČNÍ PRÁCE

Název disertační práce:	**PLASMA TREATMENT OF TEXTILE FABRICS**
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Obor doktorského studia:	textilní technika
Forma studia:	prezenční
Školící pracoviště:	Katedra textilní chemie
Školitel:	Doc. Ing. Jakub Wiener, PhD
Školitel specialista:	-

Liberec 15.3.2010

Chapters:

1-Introduction to plasma

Plasma is by far the most common form of matter. Plasma in the stars and in the tenuous space between them makes up over 99% of the visible universe and perhaps most of that which is not visible. On earth we live upon an island of "ordinary" matter. The different states of matter generally found on earth are solid, liquid, and gas. We have learned to work, play, and rest using these familiar states of matter. Sir William Crookes, an English physicist, identified a fourth state of matter, now called plasma, in 1879. Plasma temperatures and densities range from relatively cool and tenuous (like aurora) to very hot (like the central core of a star). Ordinary solids, liquids, and gases are both electrically neutral and too cool or dense to be in a plasma state. The word "PLASMA" was first applied to ionized gas by Dr. Irving Langmuir, an American chemist and physicist, in 1929.

In physics and chemistry, a plasma is typically an ionized gas. Plasma is considered to be a distinct state of matter, apart from gases, because of its unique properties. "Ionized" refers to presence of one or more free electrons, which are not bound to an atom or molecule. The free electric charges make the plasma electrically conductive so that it responds strongly to electromagnetic fields. Plasma typically takes the form of neutral are surrounded by an equal number of negatively charged electrons, and each atom is gas-like clouds (e.g. stars) or charged ion beams, but may also include dust and grains (called dusty plasmas). They are typically formed by heating and ionizing a gas, stripping electrons away from atoms, thereby enabling the positive and negative charges to move more freely. In an ordinary gas each atom contains an equal number of positive and negative charges; the positive charges in the nucleus electrically "neutral." A gas becomes a plasma when the addition of heat or other energy causes a significant number of atoms to release some or all of their electrons. The remaining parts of those atoms are left with a positive charge, and the detached negative electrons are free to move about. Those atoms and the resulting electrically charged gas are said to be "ionized." When enough atoms are ionized to significantly affect the electrical characteristics of the gas, it is a plasma. A typical plasma system consists of a gas inlet, a reactor vessel, a vacuum pump, a matching network, and a power source. Various reactors have been used in plasma processing, for dc and low-frequency glow discharges, internal electrodes are necessary.

A typical reactor is a bell jar with circular or square electrodes. As the frequency increases, electrodes maybe placed out side the reactor vessel. Plasma treatment has been used to improve print ability, wettablility, bond ability, biocompatibility, surface hardness, and surface heat resistance. It is also a means of cleaning polymer surfaces without a solvent and of introducing cross-linking at the surface.

The different types of gas or mixtures of gases that can be used for plasma treatment of polymers include argon, helium, hydrogen, nitrogen, ammonia, nitrous oxide, oxygen, carbon dioxide, sulfur dioxide, water, and tetrafluoromethane. Oxygen and oxygen-containing plasmas are the most frequently and are very effective at increasing the surface energy of polymers. Nitrogen and nitrogen-containing plasmas are used to produce nitrogen functionality such as amino groups on polymer surfaces. Fluorine and fluorine-containing plasma are used to decrease the surface energy and to increase the hydrophobicity of polymer surfaces. Each gas produces a unique modified surface. In an oxygen plasma two process occur simultaneously: etching of polymer surface through the reaction of atomic oxygen with the surface carbon atoms, giving volatile reaction products; and the formation of oxygen functional groups at the polymer surface through the reactions between the active species from the plasma and the surface atoms. The balance of these two processes depends on the operation parameters of a given experiment. Many parameters such as the nature of polymer substrate, the temperature of the substrate, electrode materials, pressure, power level, and gas flow rate play a significant role in affecting the outcome of a plasma treatment[1-5].

2-Plasma Application

Plasmas underlie numerous important technological applications and devices as well as our understanding of much of the universe around us. Plasma processing technologies are of vital importance to several of the largest manufacturing industries in the world. Foremost among these industries is the electronics industry, in which plasma-based processes are indispensable for the manufacture of very large-scale integrated microelectronic circuits. Plasma processing of materials is also a critical technology in, for example, the aerospace, automotive, steel, biomedical, and toxic waste management industries. Most recently, plasma processing technology has been utilized increasingly in the emerging technologies of diamond film and superconducting film growth. Using plasma technology to modify textile surfaces, etching , cleaning, polymerization and deposition reactions can be used to obtain nano-particle or nano-porous structures. The reactive plasma particles and radiation yield a nano-scaled interaction with material surfaces by chain scission and cross-linking reactions, radical formation, etching or deposition. The bulk properties of materials can thus be maintained. Moreover, it is a dry and eco-friendly technique, avoiding waste production as found in wet chemical processes. However, for the transfer into industry, both the feasibility of scale-up and economic aspects have to be regarded [4-13].

Some kinds of plasma technologies are discussed as bellow:

2-1-Plasma cleaning

During textile manufacturing, sizing agent, mineral oils or acrylate-based spin finishes are applied, which form a film around the yarn or individual fibers to reduce friction and electrostatic charging. Due to the interaction of reactive plasma species, textile surfaces can be etched physically and chemically. Ion bombardment, radical density and VUV (vacuum ultraviolet) radiation determine the etching rate depending on reactor geometry, plasma excitation, gas type, flow, power, and pressure and textile material. Typical etch rates of organic materials are a few nanometers per second. Therefore, a plasma treatment can be used for cleaning of manufacturing residuals on textiles. Plasma cleaning is a prerequisite to obtaining good adhesion, e.g. to a subsequent plasma coating, and can be performed in a one-step process [5].

2-2-Plasma Metalization

For the metallization of textiles, sputter-based processes can be effectively used. Sputtering can be characterized as a non-equilibrium process at the energy range of interest for film deposition. Sputtering is initiated by the impact of energetic particles (in order of 100 eV) on a target material, e.g. a metal. The incident particle cause a multiatom kinetic collision process, whereby atoms near the surface may be dislodged with enough energy to overcome the surface binding energy and be emitted from the target. These atoms are known as sputtered atoms, and when they deposit on some other surface, the process is called sputter deposition. Inert gases such as argon are generally used for the sputtering of metals, whereas an addition of reactive gases (O_2, N_2, etc) yield reactive sputtering and e.g. metal oxide or nitrides. Moreover, alloys, ceramics, and polymers can be used as target materials. The energy of the incident particles can be enhanced by electrical and magnetic fields, while avoiding collisions. Therefore, we are mainly using magnetron sputtering with argon at a pressure of 1 Pa to obtain metallization on textiles and fibers [5].

2-3-Plasma modification

Plasma modification of polymer surfaces may be categorized in to two major types of reaction:

Plasma treatment and plasma polymerization.

Advantageous of plasma processes include the following:

1. Modification can be confined to the surface layer without modifying the bulk properties of the polymer.
2. Exited species in gas plasma can modify the surfaces of all polymers, regardless of their structures and chemical reactivity.
3. By choice of the gas used, it is possible to choose the type of chemical modification for the polymer surface.
4. The use of gas plasma can avoid the problems in countered in wet chemical techniques such as residual solvent on the surface and swelling of the substrate.
5. Modification is fairly uniform over the whole surface.

The disadvantages of plasma processes are as follows:

1 Some of Plasma treatments must be carried out in vacuum. This requirement increases the cost of operation.

2 The scale-up of an experimental setup to a large production reactor is not a simple process.

3 The plasma process is extremely complex.

In general, reactions of gas plasmas with polymers can be classified as follows:

1. Surface reactions: Reactions between gas-phase species and surface species and reactions between surface species produce functional groups and cross-links, respectively, at the surface. Examples of these reactions include plasma treatment by argon, ammonia, carbon monoxide, carbon dioxide, fluorine, hydrogen, nitrogen dioxide, oxygen, and water.
2. Plasma polymerization: The formation of a thin film on the surface of polymer via polymerization of an organic monomer such as CH_4, C_2H_6, C_2F_4, or C_3F_6 in plasma. It involves reactions between gas-species, reactions between gas-phase species and surface species, and reactions between surface species.
3. Etching: Materials are removed from a polymer surface by physical etching and chemical reactions at the surface to form volatile products. Oxygen plasma and oxygen and fluorine-containing plasmas are frequently used for the etching of polymers. [4, 5]

3-Our Experimental works

Several methods, based on physical and chemical modification of polymeric materials can be used, and one of the most important is the plasma treatment.

Previously, several wet treatments have been made, but the increase in industrial applications prompted the search for more profitable and environmentally clean process, such as low pressure plasma techniques. So we tryed to use Plasma Treatment as a new, dry finishing methode, to have new usage of textile fabrics.

At below, the description of our experimental works are mentioned.

3-1-Investigation of Antibacterial Activity on Cotton Fabrics with Cold Plasma in the Presence of a Magnetic Field.

It has been recognized that microorganisms, can thrive on a textile substrate. Natural fibers such as cotton are more susceptible than synthetics because their porous hydrophilic structure retains water, oxygen, and nutrients, providing a perfect environment for bacterial growth.

A variety of antibacterial finishes have now been developed for application to textiles. Earlier efforts were based on insolubilization of inorganic compounds, like copper and other organometallic salts. Copper sterilization capabilities prevent the growth of bacteria, fungi, and germs. Low temperature plasma (LTP) is a useful technique for surface modification of polymers and textile fabrics in dry systems. In this study, we have used a DC magnetron sputtering system for creating antibacterial properties on cotton fabrics. A copper anode and cathode were used, and samples were placed on the anode. The cathode particles were scattered by attacking active ions, radicals, and electrons. Copper particles were deposited on the surface of cotton samples, and the antibacterial has been developed, through incorporation of copper particles on fabric surfaces. The antibacterial properties of the fabrics were connected with the presence of copper on their surface . After plasma treatment, the physical and chemical properties of the fabrics were examined by surface analysis methods and textile technology tests. Also the antibacterial efficiency was determined by the Halo method (Figure 1). The experimental work suggests that the change in properties induced by LTP can effect an improvement in certain textile products [14].

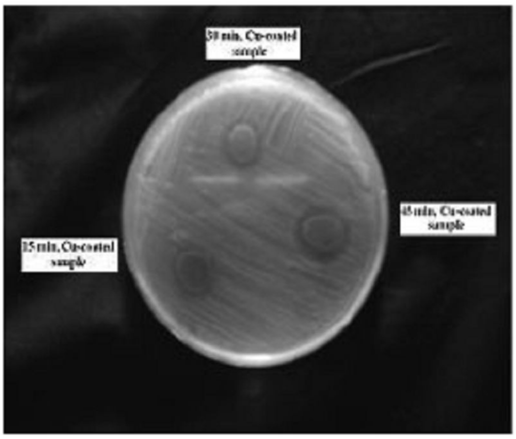
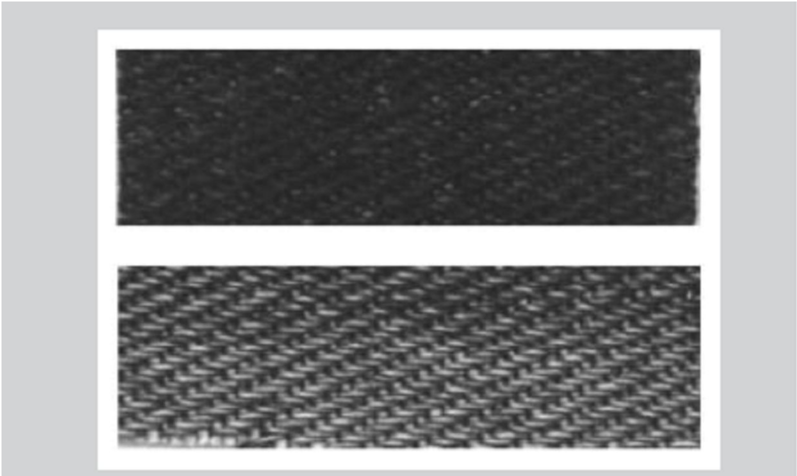


Figure 1: The Antibacterial activity of Cu-Coated samples for different duration of times.

3-2-Decolorization of Denim Fabrics with Cold Plasmas in the Presence of Magnetic Fields

In this research, instead of using stonewash technique for decolorizing of fabrics, the sputter technique was used. This technique does not need pumice stones, or the related enzymes which are usually expensive and tend to reduce the materials strength. In addition, the duration of the process (about15 min) is much shorter than the time needed for stonewashing (more than 90 min). Denim fabrics were chosen (as our main target) for this investigation, and Ar gas was used as the proper medium in the LTP apparatus. In LTP the dyestuff is removed electrically through the impact of active particles (ions, radicals, electrons, etc) with the fibers, thus leaving a very smooth and varnish surface on the fabrics. By changing the duration of the LTP process from 2.5 to 15 min, a gradual change in the color of denim was observed. However, a period of 15 min was found to be enough for achieving a proper decolorization. The appearance views for a 15 min treated sample, as well as for the untreated denim are shown in Figure 2 . It should be noted that no yellowing effect was observed, and that no etching effect was found in the treated samples. This is due to the low temperature of the plasma, and to the low electrical voltage and current applied in this experiment [15]



Photographs of denim samples before (top) and after (bottom) a treatment with a low-temperature Ar plasma.

Figure 2. The photographs of untreated and LTP Decolorized denim.

3-3-Comparison between decolorization of denim fabrics with Oxygen and Argon glow discharge

In this study, we have used a low temperature plasma, produced by a DC magnetron sputtering device, for decolorizing of denim fabrics, and the effect of using different gases such as Argon and Oxygen as the discharge medium have been investigated. The results obtained under equal periods of time have been compared and the effect of washing on the treated denims has been reported.

In this research instead of using stonewash technique for decolorization of denim fabrics, we have examined the sputter technique. This technique does not need any pumice stone or related enzymes which are usually expensive and tend to reduce the strength of the materials.
In this study, the decolorization of denim fabrics by two non polymerizing gases such as Ar and O_2 have been investigated and the results have been compared. In sputtering treatment, attacking of active particles (ions, radicals, electrons, etc.) to the surface of fabric placed on the cathode, would sputter the surface dyes from the fabrics. In Ar LTP the dyestuff are removed from the denim, leaving a very smooth and varnish surface on the fabrics. As Argon is not a reactive gas, no reaction appears between fabrics and this gas, while in Oxygen sputtering, in addition to sputtering of the surface dyes, the Oxygen active radicals can create functional groups on the surface of denim fabrics, so, some dyes that remained on the surface of fabrics would be oxided. However after washing the treated samples, the varnish of the oxygen treated sample looks better than the argon treated one. This is because that, in water environment, the affinity of oxided dyes to water is more than that of fibers, so the oxided dyes would be removed by washing. And the results of reflective spectroscopy confirm it.
To investigate the effect of LTP on the strength of the fabrics, we compared them by measuring their tensile strength using a tension test machine (INSTRON 4302). The maximum load at break measured was about (152 N/Cm) and the maximum strain was 13.12% for both treated and untreated samples. Thus no detectable difference was obtained within the accuracies of the measurement.[16]

3-4-Effect of Using Cold Plasma on Dyeing Properties of Polypropylene Fabrics

The dye-ability of hydrophobic fabrics, such as the PP fabrics we evaluated in this study, is very poor. It is known that introducing hydrophilic sites on the hydrophobic fabrics can improve the dye-ability of these fibers. Plasma modifications resulting in unsaturated bonds and/ or free radicals on the surface of the fabrics have a significant influence on the overall surface changes and consequently on dye-ability. In this research work, PP fabrics were treated with LTP of Oxygen and Nitrogen for different period of times, different condition of power and pressure. The best condition was treatment for 7 min at the power of 120 watt and pressure of 5×10^{-2} torr. As it was measured, the reflection factor of dyed LTP treated samples were less than dyed untreated sample. Our results show that the O_2 and N_2 plasma treatment are effective in increasing the dye exhaustion of PP with anionic, cationic, disperse and direct dyes. Furthermore, the colors achieved much more brilliant shades with the LTP treatment. The results show that, the average of K/S were first increased with the prolonged the LTP exposure time, reached a maximum generally at about 7 min, and were then decreased. Because, by increasing time of exposure some Al particles were deposited on the surface of the samples. As is evident from the FTIR measurement, O_2 plasma treated PP incorporates a long oxygen element in form of C-O and O-H (negative sites) in the fiber surface and increase electro negativity. So the dye exhaustion for cationic (basic) dye with positive sites increases considerably. It can be seen that, average K/S value of O2-7 min sample, which was dyed with this dye, is 3 times more than average K/S value of untreated one. Furthermore, by creating N-H groups (positive sites) on the surface of PP fabrics with N_2 LTP treatment, the dye exhaustion for direct and anionic dyes (with negative sites) increases. Not that there were no significant color changes either with repeated washing cycles or with a long period of storage, which indicates that the stability of dye attachment to the fabrics. It was shown that the Reflection factor of dyed O_2 LTP treated sample with disperse dye is less than Dyed N_2 LTP treated one. It shows that the disperse dye exhaustion of O_2 LTP treated sample is more than N_2 LTP treated one. But it is not noticeably, because Disperse dyes don't have any positive or negative sites [17].

In this research work, the dye-ability of Polypropylene Fabrics is improved by using low temperature plasma treatment. The dye-ability of PP fabrics which treated by LTP of N_2 is increased with anionic dyes, and by creating OH and C=O groups on the surface of the fabrics with O_2 LTP treatment, the dye exhaustion for cationic dye increases noticeably. So we can dye PP-O2 LTP treated sample with cationic dyes easily. And we can have new usage of PP fabrics as textile garments. The present examples show that plasma technology performed under reduced pressure, leads to variety to processes to modify fiber or textile materials to fulfill additional highly desirable requirements.

3-5-Aluminum coatings on cotton fabrics with low temperature plasma of argon and oxygen

In this article, we have studied the properties (especially water repellency) of cotton coated by a thin layer of aluminum. The process has been performed in a low temperature plasma medium, using a magnetron sputtering device. We have also investigated the effect of different gases such as argon and oxygen as the discharge medium on the properties of the obtained samples. The results which are exposure time dependent show a good repellent property for 30 min of treating in argon medium under the condition of our experiment. However, when O_2 is used in the system, the cotton property changes to become hydrophilic of which the factor decreases as we increase the time of treating.

The deposition of the metal layer (aluminum) was realized using a magnetron sputter device with a DC sputter source on a laboratory scale. The sputtered metal particles were deposited on the surface of the fabrics, which were placed on the aluminum anode.
The quality of water repellency of the samples were evaluated by water drop test in which drops of controlled size were placed at a constant rate upon the fabric surface and the duration of the time required for them to penetrate to the fabrics were measured. The results shown, the water repellency of the cotton, when Ar has been used as the discharge medium, has been increased as we have increased the duration of LTP process. On the contrary for the case of O_2 the repellency of the samples has been decreased to a few seconds which are much lower than those of corresponding values for argon (few minutes). These values which are even lower than the repellency of untreated cotton, indicates that the samples have been hydrophilic rather than being water repellent. This hydrophilicity is of course due to the effect of O_2 on the cotton fibers and indicates that, this property has become more effective than water repellency obtained due to the coating by Al, at least in the first few minutes of the experiment.
Adhesion of coated cotton was tested by washing the samples for several times. The results show a little decrease in water repellency factor after each period of washing with water which tends to remain constant at 70% after several turns (more than ten times). But by washing samples with non-ionic detergent the absorption time is increased to 16 min. It maybe because of creating chemical complex on the surface of the samples. This complex affects the water repellency properties [18].

3-6-Effect of Electron Irradiation on printability of Polypropylene (PP) fabrics, (Novel methode for Decoration of PP fabrics)

Polypropylene (PP) has a very low value of the surface free energy (approximately 20-25 mJ/m^2). Due to low surface energy, Polypropylene has very weak hydrophilic properties and doesn't have any affinity to cationic dyes .
In this study, some parts of Polypropylene fabrics (PP) were covered by mask, and then they were irradiated by electrons with different energies (Figure 3).

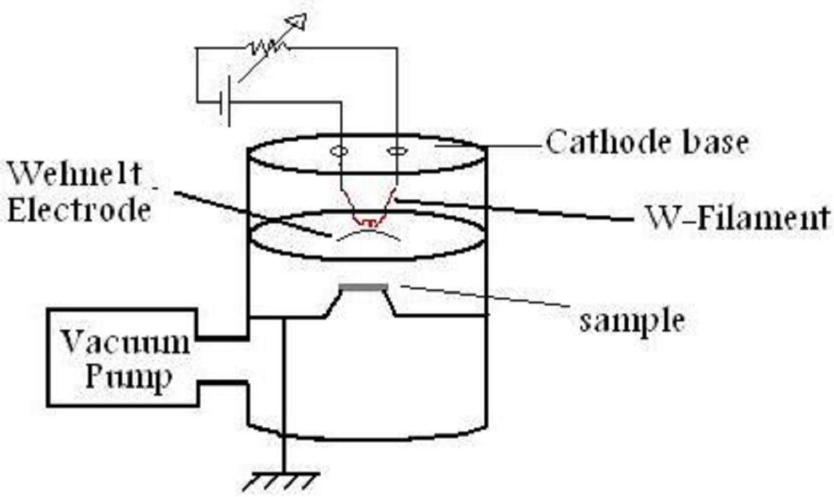


Figure 3: The Schematic view of experimental setup.

After Electron Irradiation, the samples were dyed with cationic dyestuff. The Electron Irradiated parts can be dyed and by this work we can print or decorate the polypropylene fabrics and Films easily. The treated surfaces were characterized by Scanning Electron Microscope (SEM), Reflective spectroscopy and FTIR. Also, light and wash fastnesses of printed samples were measured.

As we know, pigment printing method requires additional materials such as gauze, screen, screen frame, screen lake, etc. and these affect product costs. Moreover, this process requires longer times compared to Electron Beam (EB) designing. On this account EB designing is more advantageous. Moreover, EB designing process does not include any after-treatments such as drying and fixating which increase the production time and costs. The results from this work show that the EB-based designing process represents a serious competitor of the conventional technologies .

And just by dyeing the Electron Irradiated samples, the printed look appeared on the surface of PP fabrics, it is because of this matter that, PP doesn't have any affinity to cationic dyestuffs, but after EB treatment, cationic dye can be adsorbed by irradiated parts of fabrics easily.

In order to study the chemical modification of the electron irradiated part of fabrics, Fourier transform infrared spectroscopy is used. It shown only slight increase in absorbance at 1720 cm−1 (C=O) band and 3400 cm−1 (O-H) band and 1080-1300 cm^{-1} (C-O) after electron irradiation can be noticed. The improvement of dye-ability properties of these uncovered parts confirmed that, electron bombardment activated successfully the surface of uncovered PP fabrics. The main effect of electron beam treatment of a polymer is the transfer of energy towards the respective polymer surface .In function of the molecular structure of the polymer, one of the following events could proceed : cross-linking , chain scission or radical stabilization. In the case of polymer treatments by Electron Beam, electrons are accelerated towards the exposed surface and lead to an increased reactivity of the respective surface. This fact is possible due to the breaking of the different bonds and further formation of free radicals. After the polymer samples are brought out from the reactor, the reaction of the oxygen from the atmosphere with the free radicals takes place, and thus surface functionalization is obtained. This functionalization is more important for the materials that have no oxygen-containing groups in their initial composition. The improvement of dye-ability properties of these uncovered parts confirmed that, electron bombardment activated successfully the surface of uncovered PP fabrics.

In this study, Electron Beam Irradiation was used as a novel method for decoration of PP Fabrics. The highest K/S is obtained and the fastness properties range between good and excellent for samples printed using electron irradiation, this is true irrespective of the type of printed fabric. In this research work, the physical and chemical properties of PP fabrics were improved by using electron beam irradiation with different energy of bombardment.

By this treatment, the wet ability and Dye ability of PP were increased significantly through creating (-O-H), (C=O) and (C-O) groups on the surface of samples where hydrophobic properties changes to hydrophilic.

And we could dye the uncovered electron irradiated parts of PP fabrics with cationic dyestuff and decorate the PP fabrics without any thickener and auxiliaries as it can be seen in Figure 4(d).

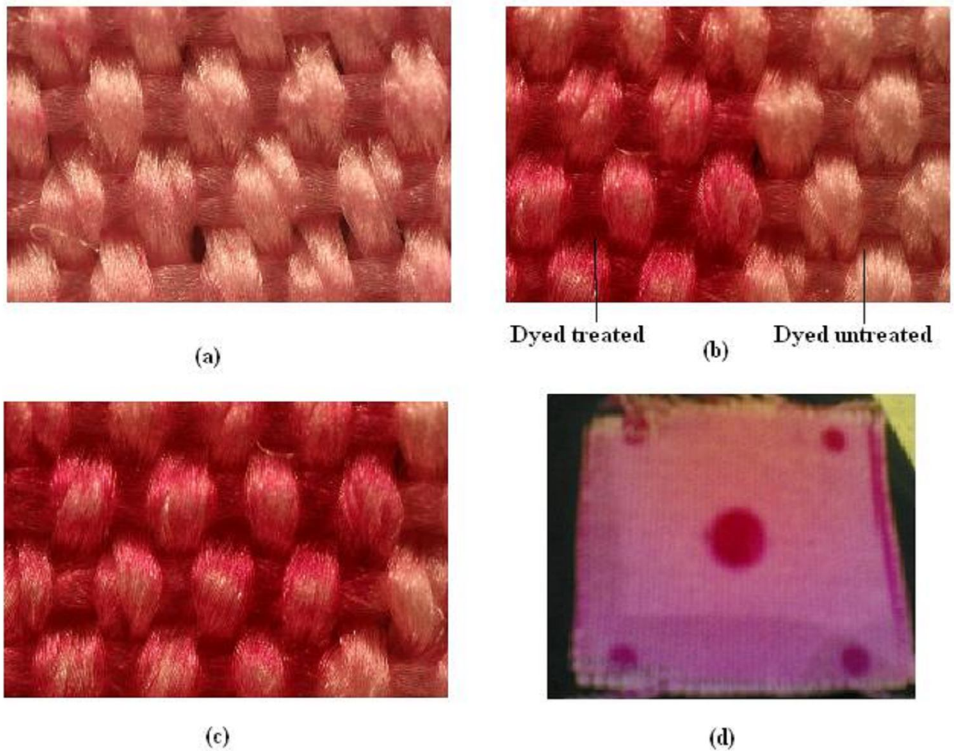


Figure 4: The photo of printed samples

It is expected that, EB irradiation which has been known for a long time and is being used in different branches of industry, in the near future will conquer polymer as well [19].

3-7-Surface Modification of Poly Vinyl Chloride (PVC) Using Low Pressure Argon Plasma.

In this study, commercial Poly Vinyl Chloride (PVC) films treated by argon plasma in the cylindrical glass tube which is surrounded by DC variable magnetic filed, under different condition of position of sample in plasma reactor and time of exposure. Effect of plasma treatment on the hydrophilicity and adhesive properties of the films was studied by measuring contact angle, and surface properties of treated samples were investigated by using different instruments. Characterization of the functional changes due to the plasma treatment has been carried out by means of Fourier transform infrared spectroscopy (FTIR). The surface topography of the untreated and Plasma-treated films was analyzed by Atomic Force microscopy (AFM). The optical changes of treated samples were investigated using Reflective Spectrophotometry.
PVC is a slightly hydrophobic polymer with water contact angle around 90° without any treatment. Values of contact angle on PVC film before and after Argon-plasma treatment are shown in Table 1. Contact angle is a measure of non-covalent forces between liquid and the first monolayer of material. Thus, in a case of strong interactions between phases, the liquid drop spreads on the solid and wet it. The PVC films treated with the argon plasma showed smaller contact angle than the original PVC film, and their surfaces became hydrophilic. The hydrophilicity showed a strong dependence on the plasma treatment time of Argon -plasma

and the sample position. As It Can be seen in Table 1, by increasing time of exposure the contact angle decrease, thus, the plasma treatment renders the initially hydrophobic material into a hydrophilic one.

Table 1:The contact angles (°)of water on untreated and plasma treated samples.

Sample Position	Time of plasma Treatment	Contact Angle
Untreated	0	90°
On the Cathode	60	66°
On the Cathode	100	60°
On the Anode	60	74°
On the Anode	100	63°
Between on Cathode and Anode	60	64°
Between on Cathode and Anode	100	55°

Detailed information on surface topographical modifications induced by plasma treatment on PVC Films was obtained by atomic force microscopy (AFM), Fig. 5 (a)–(c) shows some of the AFM images obtained in a systematic investigation on the topographical changes undergone by PVC films in successive Argon plasma treatments under fixed operating conditions. As shown in Fig. 5(a), the original surface of untreated PVC film was characterized by the presence of wave like patterns, all oriented in the same direction. Fig. 5(b) points out that a 60-s- plasma treatment gave rise to pits and craters, almost uniformly distributed on the surface.

Prolonged plasma treatment (of the order of 100 sec) finally led to seeing such features, significantly (Fig. 5(c)). As it can be seen in Figure 5 (b, c), some porous area created on the surface after plasma treatment. This topological change can help to increase hydrophilicity of the samples. According to data of Contact angle in Table 1 and AFM images in Figure 5, plasma treatment causes increasing the roughness of samples and thus increasing the hydrophilicity of them. By this method of surface modification, the poor properties of PVC such as Poor biocompatibility and adhesive can be improved. The results show that, the position of Samples inside of plasma reactor is very important Parameter.

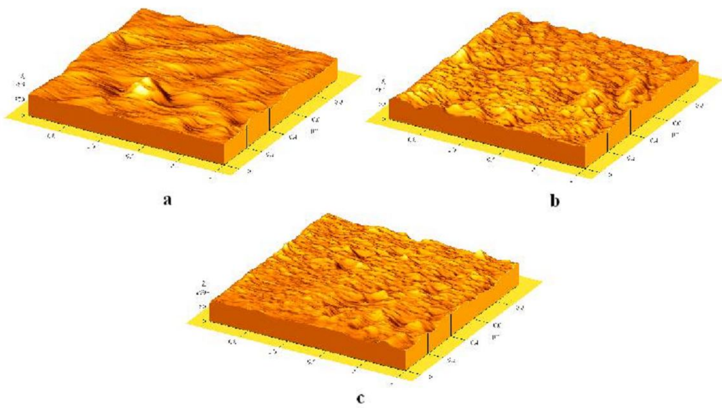


Figure 5: AFM image of (a) virgin sample,(b)Plasma treated sample for 60s onThe Anode, (c) Plasma Treated sample for 100s on the Anode.

By changing the position of samples, we can change the characteristics of PVC in different applications. By modification of PVC using Low Temperature Plasma (LTP) treatment, transmission of treated samples was decreased, and the Reflection factor remain constant. This behavior is very important for packaging industry, because the percentage of light transmittance is reduced, so lifetime and shelf time of different materials are increased. [20].

3-8-Ion Beam Modification of Polypropylene Fabrics

The main goal of this work was examination of structural and compositional changes in the Polypropylene (PP) fabrics caused by ion irradiation. In this work, the PP fabric were irradiated with CO_2 ions. The Implantation conditions (i.e, exposure time, beam current, and discharge power) were changed to control the extend of surface modification and the effects of irradiation were studied using different instruments. Also dye ability of the untreated sample and treated under different conditions were investigated by using a 3% wt aqueous solution of a basic dyestuff.

The obtained data show that, ion beam processing of PP fabrics allows an adjustable modification of their surface properties. The functional groups on the surface of samples were examined using FTIR spectrometer. Moreover, dyeing properties for treated fabrics has been tested. Significant increase in color strength has been achieved. Morphology of samples was examined by Scanning Electron Microscopy (SEM).

The PP fabric was mounted on a sample holder and placed inside a vacuum system Fig 6.

Carbon Dioxide ion beams at energies of 1 and 2 keV were implanted, using an Ion Beam Sputtering system with Kauffman Ion Source, at the Plasma Physics Research Center (Tehran, Iran).

Vacuum chamber was evacuated to the base pressure of 9×10^{-3} torr using rotary pump, and then to pressure of 10^{-5} torr using turbo pump. After filling the chamber with 10^{-2} torr of working gas (CO_2), the filament, Discharge, accelerator and focusing system were generated , respectively.

The ions were produced via a multi-step process: that is, ions are initially formed by stripping electrons from source atoms in plasma. The beam of ions is then accelerated using a potential gradient column. A series of electrostatic lens elements shapes the resulting ion beam and scans it over an area in a work chamber containing the samples to be treated. One side of samples was treated for duration of 3 minutes.

The dosage of 1×10^{11} ions/cm^2 was used, and the implantation was done with different beam current below 1mA to avoid excessive heating and thermal degradation.

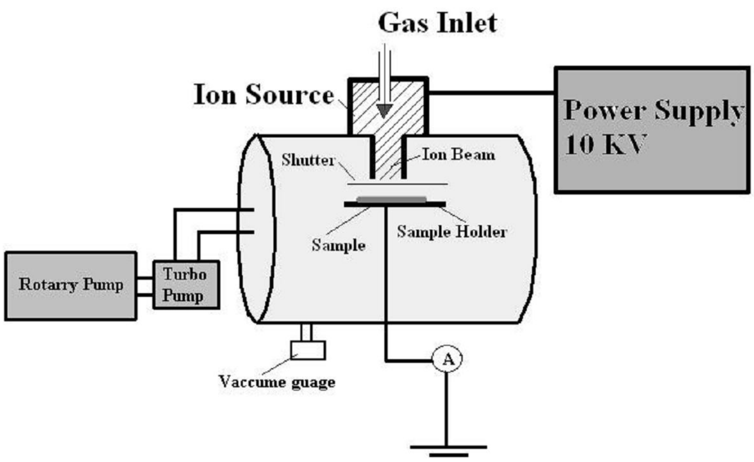


Figure 6: Schematic view of Ion Implantation set up.

In this research work, the dye-ability of Polypropylene Fabrics is improved by using Ion implantation treatment. The cationic dye-ability of treated PP fabrics by creating OH and C=O groups on the surface of the fabrics increases noticeably. So we can dyes PP-Ion implanted samples with cationic dyes easily too. And different condition of Ion Implantation technique were investigated. [21].

3-9-Study of Surface Modification of Wool Fabrics Using Low Temperature Plasma.

Owing to the selective modification of wool surface, LTP leads to the formation of new surface group. Plasma treatment of wool is confined to the fabric surface, leaving the bulk properties unchanged.

The surface Characterization was performed using XRD, FTIR and SEM imaging, so allowing the selection of treatment parameters for reproducible, efficient and stable surface modification. The absorption time were utilized to analyze the result of the treated samples. The changes in these properties are belived to be related closely to the inter-fiber/ inter-yarn frictional force induced by LTP treatment.

Wool plain woven fabrics (Iran Merinus Co, Iran) were used in this work. The fabrics were weaved by 20 denier warp and weft yarns composed of 36 filaments. For sample preparation, size residue and contamination on the fabrics were removed by conventional scouring processes, which the fabrics were washed with 0.5 gl^{-1} sodium carbonate and 0.5 gl^{-1} anionic detergent solution (dilution ratio to water =1:10) at 80^{0C} for 80 min and then washing was conducted twice with distilled water at 80^{0C} for 20 min and once at ambient temperature for 10 min.

The DC magnetron sputtering reactor was used to treat the wool fabrics, and non-polymerizing reactive gases, such as O_2, N_2 and Ar were used to modify the wool surface. In the reaction chamber, a sheet of wool fabric was placed on the anode or cathode. Details of samples are shown in Table 2.

Table 2. Description of samples.

Sample	Description
No1	Sample was placed on the cathode. Ar gas was used for 7 min
No2	Sample was placed on the cathode. O_2 gas was used for 7 min
No3	Sample was placed on the Anode. O_2 gas was used for 7 min
No4	Sample was placed on the Anode. N_2 gas was used for 7 min

Before the process started air and old gases had to be pumped out by the vacuum pump, thus almost a vacuum level was created in the reaction chamber. Afterwards, plasma gas was introduced into the reaction chamber. Discharge voltage was 500V, discharge current was 200 mA and the inter-electrode distance was 35 mm. The pressure remained at 0.02 Torr for the entire glow-discharge period.

The SEM analysis of surface morphology reveals slight changes whish occur on the surface of wool fibers as a result of plasma modification. The rising parameters of LTP treatment (time and power) lead to a slight increase in these changes causing a rounding of scales,

microcracks, recesses and tiny grooves, all caused by the etching of the material . SEM micrographs of wool fibers after plasma modification are shown in figure 7.
As It can be seen in Figure 7, the scale of samples which were put on the cathode were destroyed more than other samples. It showed that by putting samples on the cathode the rate of etching is increased and it can help to anti felting of wool fibers. For N_2 and O_2 plasma treatment, that, samples where put on the anode, minimal damage occurs to the scale structure as a result of the glow discharge treatment.
The most important effect of LTP treatment of wool is the change in the character of the wool fiber surface from hydrophobic to hydrophilic and anti felt.

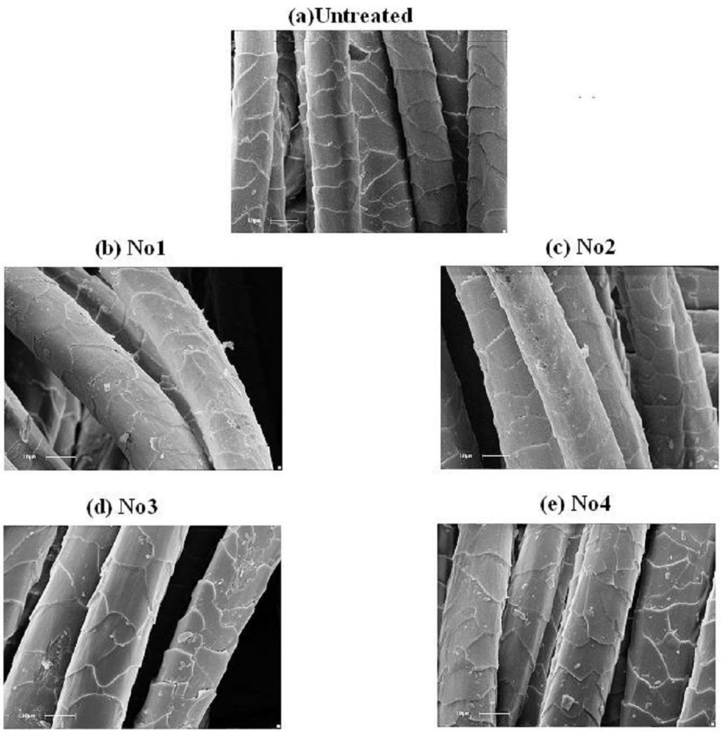


Figure 7: SEM images of treated and untreated samples.

For dyeing process, aqueous solutions, containing 3.0 wt. % of the Acid dye were employed for dyeing wool fabrics. The bath ratio was 1:100 (1 g of fiber in 100 ml of dye solution). The following dyeing condition was adopted: Initial temperature 40 ^{0C}, followed by a temperature increase of $3^{0C}min^{-1}$ up to 80 ^{0C}, holding for 30 min at 80^{0C}. 5 g/lit of acetic acid for pH adjustment, were added for anionic dyeing processes. After dyeing, the fabrics were rinsed with cold-hot-cold water and then dried at room temperature.
It showed, the reflection factor of dyed LTP treated samples were less than dyed untreated sample. The results show that the O_2 and Ar-Cathode plasma treatment are more effective in increasing the dye exhaustion of wool with anionic dye. Furthermore, the colors achieved much more brilliant shades with the LTP treatment. Also the K/S value of LTP treated samples is more than original one, however, this value is more for Ar and O_2-cathode LTP treated samples.

The quality of water repellency of the samples were evaluated by water drop test in which drops of controlled size were placed at a constant rate upon the fabric surface and the duration of the time required for them to penetrate to the fabrics were measured. After LTP treatment the water absorption time is much decreased. However this time is very low for O_2 –cathode LTP treatment.

In this research work, the surface of wool samples were changed both physically and chemically by using LTP treatment. The situation of wool samples in LTP reactor is very important factor. By putting samples on the cathode and using oxygen as a working gas, the wet ability and dye ability of wool samples were increased [22].

3-10-Influence of Dielectric Barrier Discharge treatment on Adhesion properties of Platinum coated PP foil and PP fabrics.

In this paper, an attempt was made to apply low temperature plasma treatment to improve the adhesion property of Polypropylene (PP) fabrics and foils. PP fibers have been increasingly used in textile industries for a variety of applications ranging from filtration, composites, and tissue engineering and electronic textiles. The surface properties of these polymer fibers are of importance in various applications. The surface properties of polymers can be modified by different techniques.

This paper is aimed at understanding the basic properties of platinum-deposited PP samples after treating with low temperature plasma treatment. Atmospheric plasma treatment was employed in this paper to activate and etch surface.

In this research work, the PP samples were treated by Diffuse Coplanar Surface Barrier Discharge for up to 10 minutes, and both treated and untreated samples were coated with platinum.

The textile properties of treated and untreated samples were evaluated by different standard testing methods in terms of both physical and chemical performances. The rubbing fastness were investigated according to standards methods. The morphology changes of fabrics after plasma treatment were characterized by scanning electron microscopy (SEM) and Atomic Force Microscopy (AFM). Furrier Transform Infrared (FTIR) analyses revealed chemical surface modifications occurring after the plasma treatments.

The study showed that adhesion of the Platinum to the PP fabrics and foils was greatly enhanced by the air plasma treatment. In this research work, the PP foils and Fabrics were treated with DBD with different conditions. The duration of time were changed up to 10 minutes. After DBD treatment, samples were analyzed with FTIR and AFM to achieving , best condition of DBD treatment. And we found that, power of 300w , voltage of 20 KV and 8 minutes of treatment is suitable for DBD treatment. Because for the lower condition, no significant changes were appeared on the samples, and by increasing the time of exposure , some parts of samples were melted. So the mentioned condition of DBD were used for comparing the adhesion properties of untreated and treated samples.

The performance of the DBD for the activation of the PP foil and fabric is studied by Rubbing and Abrasion tests. The corresponding chemical and topological alterations of the sample surfaces are characterized and linked to the adhesion properties.

The plasma treatment alters the chemical and the topological state of the substrate. The observed improvements in adhesion result from the combination of these effects.

The as-received PP exhibited peaks at 840, 890, 960, 1180, 1370, 1450 and 2900 cm^{-1}, which are well matched to those reported in the handbook .Upon DBD treatment, a clear peak appeared around 1708 cm^{-1}, which can be attributed to C= O stretching.

To achieve high Rubbing fastness, a strong adhesion between the adhesive and the substrate is essential. Usually this requires the formation of covalent bonds between the molecules of the adhesive and the adherent. A good match between the functional groups of the substrate surface and the adhesive is therefore of critical importance. The formation of additional functional groups at the surface is probably the most significant contribution to the adhesion improvements by the plasma treatment. Probably both the absolute number of oxygen groups and the large variety of functional groups contribute to this improvement. A Variety of functional groups can be especially advantageous when different types of adhesives are to be used. The incorporation of oxygen is also responsible for the increase in surface energy.

Adhesion properties are also strongly influenced by the surface topology. A microscopic and nano metric roughness can also lead to a mechanical interlocking between the two partners of the adhesive joint. Atmospheric pressure DBD air plasma treatment can alter samples surface microstructure and chemical compositions. The surface topology of control PP and some treated PP were measured with AFM. The average surface roughness (Ra) increases from 9.4 nm for the original PP surface to 18.3 nm, for treated specimen. AFM investigation revealed that the roughness of the films increases with DBD treatment on the samples.

After doing some chemical and physical analyses, both treated and untreated samples were coated with platinum using Sputtering system , then the adhesive properties of platinum to untreated and treated samples were measured and compared with rubbing and Abration testers.

The adhesion properties of Pt-coated DBD treated PP samples and pt-coated untreated samples were evaluated in terms of fastness towards rubbing and abrasion, using the gray scale according to I.S.O standard recommendations as shown in Table 3. Assessment of fastness involves a visual determination of either change in shade or staining of an adjacent material. The graduation of the gray tones in the scales is defined as the smallest difference in depth, which is of commercial significance.

Thus, as shown in Table 3, DBD treatment on PP samples cause increasing the adhesion of platinum particles to the samples.

Untreated coated samples have low rubbing and abrasion fastness, as compare to DBD treated ones. It shows that, the adhesive between Pt and DBD treated PP is more. It is because of creating some functional groups and morphological changes on the samples after DBD treatment. And by this treatment, the surface energy of samples is increased. By increasing the time of DBD treatment till optimums condition this feature will be more significant. Although by increasing duration of time more than 10 minutes, the bulk of samples are changed and it is not desired.

Table 3: The results of Rubbing and Abrasion fastness of both treated and untreated PP foils and fabrics.

Samples	Degree of rubbing fastness	Degree of Abrasion fastness
Untreated PP foil	3	2
DBD treated PP foil for 120 sec	4	3
DBD treated PP foil for 480 sec	5	4-5
Untreated PP Fabric	3	2
DBD treated PP Fabric for 120 sec	3-4	3
DBD treated PP fabric for 480 sec	5	5

Experimental results of the adhesion properties and surface properties are presented for the polypropylene (PP) fabric and foil before and after the DBD treatment. The adhesion properties of the activated samples are determined by Abrasion and Rubbing tests. The adhesion improvement has been related to the formation of different oxygen-containing functional groups and changes in the topology of the surface [23].

3-11-Investigation on Penetration of Electron Irradiation on Polypropylene Films.
In the present study, electron beam irradiation (with hot cathode system) has been applied for modifying hydrophilic properties of Polypropylene (PP) films and investigating of Electron Beam penetration. Electron beam facility consists of a keV electron gun and a cylindrical shaped chamber. The 11 layers of PP film were put on the sample holder inside the chamber and irradiated with accelerated electrons. And samples were Treated with different energy and beam current.

After treating the samples, some of physical and chemical properties were investigated and treated layers were compared with untreated PP film. The results of FTIR showed that, the amount of carboxyl and hydroxyl groups appeared on the surface of film treated with 20 Kv energy and electron beam current of 0.4 µA was more than the others, and by increasing the beam current and energy of electron beam, the samples were melted, so this conditions were used for the 11 layers of PP films. But the intensity of peaks related to Carboxyl and Hydroxyl groups were decreased from first layer to 11th layer. Also the intensity of peaks were decreased, for the first layer as compared with the irradiated alone sample.

For the Irradiated 2 to 11th layer, the FTIR results are similar, and no changes can be finding.

This results show that, Just Functional groups were appeared on the first layer of PP films, and no chemical changes were found in rest of layers. And as it can be seen in Figure 8, Just the first layer can be dyed, and the Hue of dyeing was decreased as compared with the same condition Irradiated alone sample.

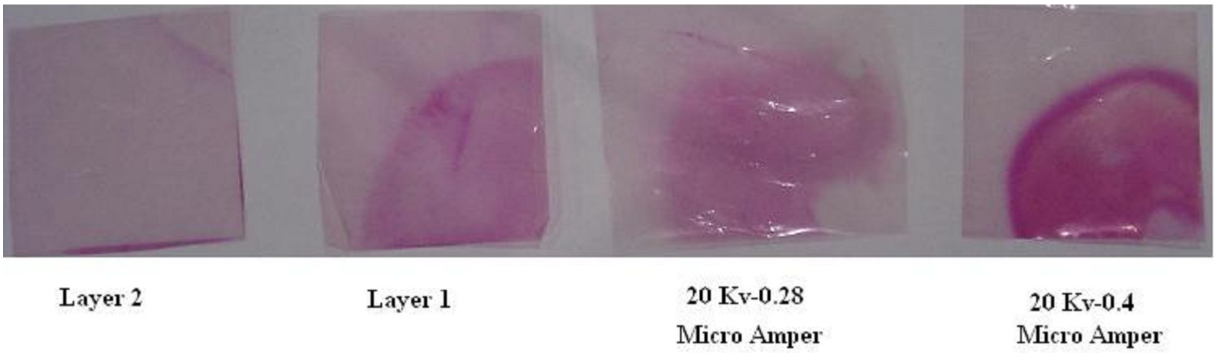


Figure 8: Photoes of Treated samples under different conditions.

The AFM results showed, by irradiation on the 11 layers of PP film, the morphological and topographical structure of the films changed as compared with untreated one. It shows that, accelerated electrons cause physical changes on the films. But as it explained before, no chemical changes were appeared on the surface of 2 to 11th layer. It means that, electrons can not break the polymer chains of second to 11th layer of PP films, and no functional radical created on their surfaces. The results showed that, the chemical changes just appeared on the first layer, but the intensity of FTIR peaks related to functional groups were lower than the alone sample that irradiated with same condition of Irradiation. And the existence of 11 layers of PP in the system causes reduction of chemical changes in the first layer.

AFM results showed, the accelerated electrons cause topographical changes on the different layer of PP film [24].

3-12 Comparison between Dielectric Barrier Discharge and Low Pressure plasma treatment on Adhesion properties and Antibacterial activity of metal coated Polypropylene fabrics.

Atmospheric and low pressure plasma treatment was employed in this study to activate and etch surface. In this research work, the PP samples were treated by Diffuse Coplanar Surface Barrier Discharge (DBD) and Low Pressure plasma for up to 10 minutes, and then treated and untreated samples were coated with copper using DC magnetron sputtering. In case of Low pressure plasma, Oxygen and Nitrogen were used as working gas. The textile properties of treated and untreated samples were evaluated by different standard testing methods in terms of both physical and chemical performances. The morphology changes of fabrics after plasma treatment were characterized by scanning electron microscopy (SEM). It was shown that the treated samples suffered morphological alterations on their surface, with the formation of ripple –like patterns , and some of spots on the surface of plasma treated PP were appeared due to the plasma particles attack on the samples surface. And the amount of porous area appeared on the Oxygen plasma treated samples is more than the others. Surface of Oxygen plasma treated Cu-coated sample was rougher than the others, But in case of DBD and nitrogen treated one, a smooth layer of Copper, sputtered on the surface of PP fabric. The results achieved by EDX confirm the results of SEM images. The amounts of copper attached to the surface of Nitrogen plasma and DBD treated samples are more than untreated and oxygen plasma treated fabrics. It is shown that, by using nitrogen plasma pre treatment, more copper particles can attach to the surface of polypropylene fabrics. Also atmospheric plasma treatment causes, more adhesion of copper particles on the surface of PP samples. After comparing the amount of copper on the surface of untreated and treated PP fabrics, then the adhesive properties of copper to untreated and treated samples were measured and compared with rubbing and Abration testers. It was shown that, plasma treatment on PP samples causes increasing the adhesion of Copper particles to the samples. Untreated coated samples have low rubbing and abrasion fastness, as compare to plasma treated ones. It shows that, the adhesive between Cu and plasma treated PP is more. It is because of creating some functional groups and morphological changes on the samples after plasma treatment. And by this treatment, the surface energy of samples is increased. And the best fastness achieved by Nitrogen plasma pre treatment. The amine groups on the main chain can act as chelating sites for metal ions.

The results related to SEM images after Rubbing have been shown that, the surface of Nitrogen plasma and DDB treated samples completely covered with Copper particles, and after rubbing, the amounts of removed copper is not significantly, but in case of oxygen plasma treatment, it can be seen that, after rubbing more amount of copper removed from the surface. the EDX results of the rubbed samples show that, after rubbing, again, more amounts of copper remain on the surface of nitrogen plasma and DBD treated samples. The amine groups and hydroxyl groups on the main chain can act as chelating sites for metal ions. And it can be concluded that, Amine groups has more affinity to chelating copper as compare to hydroxyl groups. The result of antibacterial eficciacy test on the samples were shown that, the bactera can not spread over the coated samples, and little amounts of bacteria can be counted in the plate of agar . Also the rubbed samples were analysed with antibacterial eficciacy test.

The results show that, Nitrogen plasma treatment causes more attachment between Cu particles and the surface of PP coated samples as compared with Oxygen plasma and DBD treatment. So it causes 100% reduction of Staphylococcus aureus growth in agar plate. It can be seen that, LTP pretreatment causes very good antibacterila activity on the PP fabrics. Also the durability and fastness of antibacterial activity on the surface of pre plasma treated Cu-Coated sample is very good as compared with untreated Cu-Coated one. It can be concluded that, after 2000 cycles of Abrasion on the surface of Cu-coated samples, good antibacterial efficiency remained on the Cu-Coated samples and the durability of antibacterial activity on the plasma pre treated cu-coated samples is more than that of untreated coated one, and Nitrogen plasma pre treatment is the most effective in this matter [25].

5-13-Effect of Low Temperature Plasma on Anti-Felting Properties of Wool Fabrics.

In this research work, the surface of wool fabrics are etched and oxidized by using plasma treatment, this etching is necessary to improve the felting behavior of the wool. The DC magnetron sputtering reactor was used to treat the wool fabrics, and non-polymerizing reactive gases, such as O_2, N_2 and Ar were used to modify the wool surface. In the reaction chamber, a sheet of wool fabric was placed on the anode or cathode. The aluminum post cathode because of low rate of sputtering was used. The dimensional changes of the LTP-treated wool fabric after washing were tested according to AATCC Test Method 99-1993 [21]. Due to the limited size of the plasma reaction chamber, the dimension of the fabric sample used was 65 × 35 mm^2, with a 60 × 30 mm^2 marked inside the fabric. The fabric was conditioned before measurement. The measurement was then conducted to assess the shrinkage in length of both warp and weft direction, and finally the area shrinkage was calculated. The degree of shrinkage (expressed in %) in length and area were calculated according to Equations (2) and (3) respectively.

$$\textit{Length change} = \{(l_f - l_o)/l_o\} \times 100$$

where:
lf = final length after treatment (mm),
lo = original length before treatment (mm).

$$\textit{Area change} = \{(A - O)/O\} \times 100$$

where:
A = final area after treatment (mm^2),
O = original area before treatment (mm^2).

From the shrinkage test of fabrics, it was clearly observed that the dimensional change in the warp direction was greater than in the weft direction.

The relaxation dimensional change occurred when the fabric was immersed in water without agitation, so that the strains and stresses imparted during fabric formation could be released. The fabric was then dried and reconditioned to the relative humidity of 65% at which it was originally measured. From all the LTP treatment, it was found that the LTP-treated fabric underwent only a slight change in dimension after the relaxation process, up to1.6% and 0.2% in the warp and weft directions respectively. And for the samples that were put on the cathode, there were no changes in dimensions.

In shrinkage, the untreated wool fabric also showed the greatest change in both warp and weft directions when compared with the LTP-treated fabric. Generally speaking, the variation of dimensional change between the different LTP-treated wool fabrics was very small in the weft direction, and the variation of consolidation shrinkage in the warp direction was greater than in the weft direction.

The felting dimensional change is an irreversible dimensional change which occurs in a wool fabric when it is subjected to agitation in laundering. The felting dimensional changes were greatest in both warp and weft directions among other dimensional changes. The maximum value of the felting dimensional changes in the untreated wool fabric was 10.7%, which was only a moderate change for the untreated fabric. However, when this value was compared with the LTP-treated fabric, it demonstrated that the LTP treatment could impart significant shrink-resistant and anti-felting effects to the wool fabric.

For a detailed study of how the LTP affects the overall fabric shrinkage, the area shrinkage was calculated,

it seen that the area shrinkage significantly decreased after the subsequent LTP treatment. As it can be seen, the type of gas used and the position of samples inside plasma reactor have very important role for shrink-resist properties of wool fabric. For Ar, O2 and N2-Cathode plasma treated samples we had a marked improvement in shrink resistance, whereas, this improvement for the O2 and N2-Anode plasma treated samples were not happened.

For the fabric shrinkage study, generally speaking, the wool fabric shrinkage is correlated with the frictional coefficient of the constituent wool fibers, and it is common knowledge

that LTP treatment increases the dry and wet frictional coefficient in the scale and anti-scale direction .However, the effect of the LTP process is attributed to several changes in the wool surface, such as the formation of new hydrophilic groups, the partial removal of covalently-bonded fatty acids belonging to the outermost surface of the fibre, and the etching effect. The first two changes contribute mainly to the increased wettability properties, while the last basically reduces the differential friction coefficients of the fibres, and thus decreases the natural shrinkage tendency [26].

5-14-Effect of Low Temperature Plasma on Wool Natural Dyeing and Substituted it for Mordant Treatment

In this paper, the effect of low temperature plasma treatment on the natural dyeing properties of wool and the possibility of substituted it for mordant treatment was studied. The Madder and Weld were used as a natural dyes and Copper sulphate ($CuSO_4$) and Ferrous sulphate ($FeSO_4$) as a metal mordant. Iron and copper were used as an electrode, in DC Magnetron Plasma Sputtering System.

For natural dyeing, first some of wool samples were treated with mentioned mordant, and some of them were sputtered with Copper and Iron metal particles, using plasma sputtering treatment. Then all of wool samples were dyed with mentioned natural dyes.

The color strength of plasma treated and untreated samples were analyzed using Reflective Spectrophotometer. Washing and light fastness were investigated and the results show that, the color strength and fastness of dyed wool samples are improved after plasma treatment.

The results show that,the reflection factor for the wool mordant sample with $CuSO_4$ is near to the Cu-deposited samples with different duration of plasma treatment. In Case of Dyeing with Madder, it can be concluded that, just by 3min-Cu sputtering, we can have a shade similar to the shade achieve by $CuSO_4$ mordanting. It was seen that in case of dyeing with Weld, the reflection factor of 7 and 10 min Cu-sputtered samples are near to reflection factor of $CuSO_4$ mordanted sample. By comparing the K/S values for the samples it was seen that in some cases the Cu coated samples have very good Madder and Weld dye ability as compared with dyed $CuSO_4$ mordanted sample. But the Iron sputtered samples has lower amounts of color strength as compared to treated samples with $FeSO_4$ as a mordant. It is maybe because of lower rate of sputtering for Iron as compare to Copper. It can be concluded that, by copper sputtering on the surface of wool the fastness properties of the samples is improved and fastness in range between good to excellent were achieved.

The mordant treatment with natural dyeing has two stages for better dyeing so it needs more time and substance and energy. But plasma treatment is more economic than mordant treatment, and also color strength (K/S) and color fastness in case of using plasma are often gotten better results. One stage wool dyeing has benefits such as lower energy conservation and wool fibers protection by either decreasing the temperature or shortening the processing time at high temperature during dyeing.

It can be concluded that the low temperature plasma treatment could improve the natural dying properties of wool in replace on mordant treatment. The results of tests have shown that naturally dyed plasma treated wool is characterized with good resistance to washing and light**.** And the best results were achieved for Cu sputtered samples. It can be concluded that, Cu plasma Sputtering can be substitute with mordant treatment before natural dyeing of wool fabrics [27].

4-Publications/Presentation

List of related publications

4-1-Presented papers in Conferences :

[1] M.Ghoranneviss, A.Rashidi, S.Shahidi, B.Moazzenchi, M.Mirjalili, Effect of plasma treatment on Polyester and Polypropylene fabrics, **International conference on "Low Temperature Plasma & Their Applications", October 9-12, 2004, Tabriz, Iran**

[2] S.Shahidi, B.Moazzenchi, M.Ghoranneviss, A.Rashidi, Effect of cold plasma on Polyester fabrics, **Second International Conference on The Frontiers of Plasma Physics and Technology. Feb 21-25, 2004, Goa, India.**

[3] S.Shahidi, M.Ghoranneviss, B.Moazzenchi, D.Dorranian, A.Rashidi, Water Repellent Properties of Cotton and PET Fabrics Using Low Temperature Plasma of Argon,
"XXVII International Conference on Phenomena in Ionized Gases", July 17-22 2005, Eindhoven, The Netherlands.

[4] S.Shahidi , M.Ghoranneviss, B.Moazzenchi, A.Rashidi, D.Dorranian , Effect Of Coating Aluminium With Low Temperature Plasma On Cotton Fabrics, **Fifth Asian-European International Conference on Plasma Surface Engineering, September 12-16, 2005, Qingdao, China.**

[5] M.Ghoranneviss, B.Moazzenchi, S.Shahidi , A.Rashidi, A.Anvari, A.H.Sari, H.Hoseini Decolorization Of Denim Fabrics Using Cold Plasma, **Fifth Asian-European International Conference on Plasma Surface Engineering, September 12-16, 2005, Qingdao, China.**

[6] M.Ghoranneviss, S.Shahidi , B.Moazzenchi, A.Rashidi, D.Dorranian, A.H.Sari Electron Beam Modification Of Polypropylene Fabrics, **3rd International Conference On The Frontiers Of Plasma Physics And Technology, March 5-9, 2007. Bangkok, Thailand,** Proff Ghoranneviss participated

[7] S.Shahidi , M.Ghoranneviss, B.Moazzenchi, A.Rashidi, D.Dorranian, Study Of Surface Modification Of Wool Fabrics Using Low Temperature Plasma. **3rd International Conference On The Frontiers Of Plasma Physics And Technology, March 5-9, 2007. Bangkok, Thailand,** Proff Ghoranneviss participated

[8] S.Shahidi , M.Ghoranneviss , B.Moazzenchi , A.Anvari , A.Rashidi , D.Dorranian, Investigation of Antibacterial activity on cotton fabrics with cold plasma in the presents of magnetic field , **10th International conference on Plasma Surface Engineering (PSE2006), 10-15 September 2006, Garmisch-Partenkirchen, Germany.**

[9] S.Shahidi, M.Ghoranneviss, J. Wiener, Effect of Ion Implantation on physical and Chemical Properties of Polypropylene Fabrics, **14th International Conference Structure and Structural Mechanics of Textiles 26th and 28th November 2007, Liberec, Czech Republic.**

[10] S.Shahidi , J.Wiener, M.Štěpánková**,** Influence of Dielectric Barrier Discharge treatment on Adhesion properties of Platinum coated PP and PET fabrics **,24th Symposium on Plasma Physics and Technology, 16-19 June 2008, Prague, Czech Republic**. Dr Wiener participated

[11] M. Ghoranneviss , R.Enjilela, S.Shahidi, A.Hojabri, Surface Modification Of Poly Vinyl Chloride (PVC) Using Low Pressure Argon Plasma., **2nd International conference on Functional materials & devices, ICFMD2008 , 16-19 June 2008, Kuala Lumpur, Malaysia**

[12] J.Payamara , S.Shahidi, M.Ghoranneviss, J.Wiener, Effect Of Electron Irradiation On Printability Of Polypropylene Fabrics, **2nd International conference on Functional materials & devices, ICFMD2008, 16-19 Jun 2008, Kuala Lumpur, Malaysia**

[13] M.Ghoranneviss, R.Enjilela, S.Shahidi, A.Hojabri, Effect of Low Temperature Plasma Treatment on PolyVinyl Chloride Film, **14th International Congress on Plasma Physics, 8-12 September, 2008, Fukuoka, Japan,** Proff Ghoranneviss participated

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[15] S.Shahidi , J.Wiener , M.Ghoranneviss, Investigation on penetration of Electron Irradiation on Polypropylene films, **15th International Conference Structure and Structural Mechanics of Textiles, 1th December 2008, Liberec, Czech Republic.**

[16] S.Shahidi, A.Rashidi, J.Wiener, M.Ghoranneviss, Antibacterial activity on Polyamide and Natural fabrics using Low Temperature Plasma, **2009 NSTI Nanotechnology Conference and Trade Show, May 3-7, 2009, Houston, Texas, U.S.A.**

[17] Z. Motaghi, S. Shahidi, M.Ghoranneviss' Effect of Low Temperature Plasma on Wool Natural Dyeing and Substituted it for Mordant Treatment, **7th International Conference on Asian - European Conference on Plasma Surface Engineering and the Exhibition (AEPSE2009), September 20 ~ 25, 2009, The Bexco Conference Center, Busan, Korea**

[18] S.Shahidi, A.Rashidi, M.Ghoranneviss , M.K.Rahimi , M.Bameni Moghaddam, J.Wiener, Comparison between Dielectric Barrier Discharge and Low Pressure plasma treatment on Adhesion properties and Antibacterial activity of metal coated Polypropylene fabrics**, 7th International Conference on Asian - European Conference on Plasma Surface Engineering and the Exhibition (AEPSE2009), September 20 ~ 25, 2009, The Bexco Conference Center, Busan, Korea**

[19] A.Rashidi , S.Shahidi , M.Ghoranneviss ,J.Wiener , Effect of Low Temperature Plasma on Anti-Felting Properties of Wool Fabrics. **7th International Conference on Asian - European Conference on Plasma Surface Engineering and the Exhibition (AEPSE2009), September 20 ~ 25, 2009, The Bexco Conference Center, Busan, Korea**

4-2-Published papers in Journals and proceedings:

[1] M. Ghoranneviss, B. Moazzenchi, S. Shahidi, A. Anvari, Abosaeed Rashidi , Decolorization of Denim Fabrics with cold plasma in the presence of magnets field,
Plasma Processes and Polymers, 3 (2006) 316-321, ISSN: 1612-8869

[2] M. Ghoranneviss , S. Shahidi , B. Moazzenchi , A. Anvari , A. Rashidi , H. Hosseini, Comparison between Decolorization of Denim Fabrics with Oxygen and argon Glow Discharge, **Surface and Coating Technology, 201 (2007) 4926- 4930,** ISSN: 0257-8972

[3] S. Shahidi, M. Ghoranneviss , B. Moazzenchi , A. Anvari , A. Rashidi, Effect of Coating Aluminium with Low Temperature Plasma of Argon and Oxygen on Cotton Fabrics,
Surface and Coating Technology, 201 (2007) 5646- 5650, ISSN: 0257-8972

[4] S. Shahidi, M. Ghoranneviss, B. Moazzenchi, A. Rashidi, and D. Dorranian , Effect of Using Low Temperature Plasma on Dyeing Properties of Polypropylene Fabrics,
Fibres and Polymers, Vol 8, No1, 2007, 123-129, ISSN: 1229-9197

[5] S. Shahidi, M. Ghoranneviss, B. Moazzenchi, A. Rashidi, M. Mirjalili , Investigation of Antibacterial activity on cotton fabrics with cold plasma in the presence of magnetic field, **Plasma Process and Polymers. 2007, 4, S1098–S1103,** ISSN: 1612-8869

[6] S.Shahidi, M.Ghoranneviss, B.Moazzenchi, D.Dorranian, A.Rashidi **,** Water repellent properties of cotton and PET fabrics using Low Temperature Plasma of Argon, **Published in proceeding of ICPIG 2005,17-22 July 2005,Netherlands.**

[7] S.Shahidi , M.Ghoranneviss, B.Moazzenchi, A.Rashidi, D.Dorranian, Study of Surface Modification of Wool Fabrics Using Low Temperature Plasma. **Published in IAEA** Proceeding of 3rd International Conference On The Frontiers Of Plasma Physics And Technology, March 5-9, 2007. Bangkok, Thailand

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[9] J.Payamara, S.Shahidi ,M.Ghoranneviss, J.Wiener, Effect of Electron Irradiation on dye and printability of Polypropylene (PP) fabrics, (Novel method for Decoration of PP fabrics), Accepted for publishing in **Journal of the Textile Institute**, ISSN:0040-5000

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4-3-Under publication in Journals

[1] S.Shahidi, A.Rashidi, M.Ghoranneviss , M.K.Rahimi , M.Bameni Moghaddam, J.Wiener, Comparison between Dielectric Barrier Discharge and Low Pressure plasma treatment on Adhesion properties and Antibacterial activity of metal coated Polypropylene fabrics, under publication in **Surface and Coating Technology**, ISSN: 0257-8972

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6-Summary:

In this research work, the plasma treatment was used as a new, dry, eco-friendly process for some of modern finishing treatment on textile fabrics.

By using plasma treatment, the duration of finishing processes are decreased to a few minutes.

Many parameters such as the nature of polymer substrate, the temperature of the substrate, electrode materials, pressure, power level, and gas flow rate play a significant role in affecting the outcome of a plasma treatment. The diversity of what is included in "plasma science" makes the subject difficult to characterize. However, it is that same diversity that makes it such an important contributor to a wide range of applications and technological developments. Using plasma technology to modify textile surfaces, etching, cleaning, polymerization and deposition reactions can be used to obtain nano-particle or nano-porous structures. The reactive plasma particles and radiation yield a nano-scaled interaction with material surfaces by chain scission and crosslinking reactions, radical formation, etching or deposition. The bulk properties of materials can thus be maintained. Moreover, it is a dry and ecofriendly technique, avoiding waste production as found in wet chemical processes. However, for the transfer into industry, both the feasibility of scale-up and economic aspects have to be regarded. It is expected that, plasma treatment which has been known for a long time and is being used in different branches of industry, in the near future will conquer polymer as well.

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