Sept. 6, 1966 H. C. GEEN 3,271,220

CONTACTING FIBER BONDING

Filed April 5, 1963

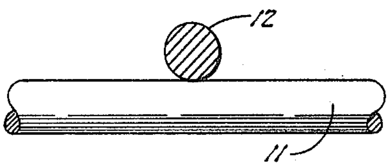


FIG. I

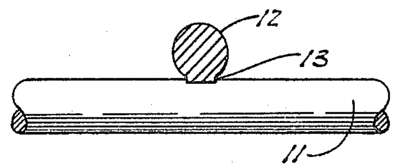


FIG. II

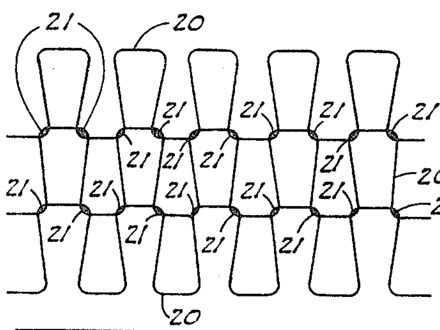
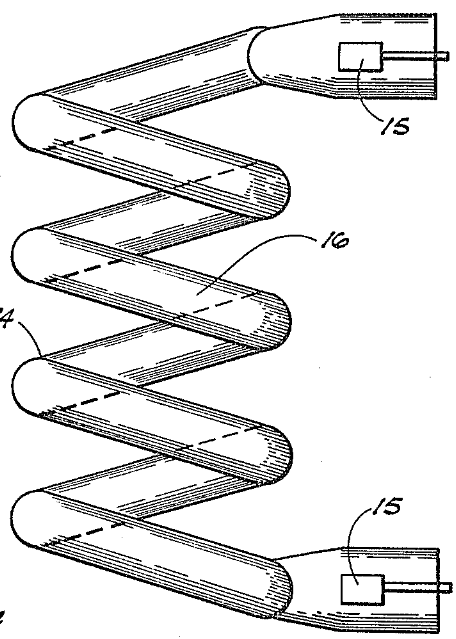


FIG. III



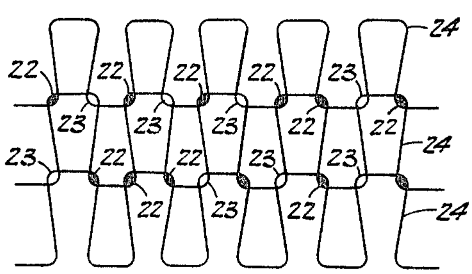


FIG. IV

FIG. V

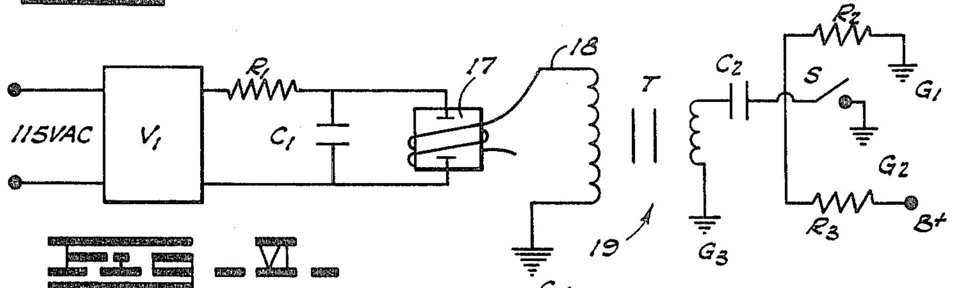


FIG. VI

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CONTACTING FIBER BONDING

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This invention relates to a method of bonding contacting fibers and more particularly to a method of bonding contacting resinous fibers. Further, this invention relates to novel bonded fabrics and in particular to novel bonded resin fabrics. More particularly, this invention relates to novel fiber intersection bonded nylon stocking fabrics and their method of manufacture.

The prior art has used adhesives to bond fiber intersections. For example, phenolic resin adhesives have been used to bond intersecting fibers in fiberglass matting. The phenolic resin adhesive usually constitutes about 30% or more by weight of the finished product. Further, the finished product is much more costly than the fiberglass alone because of the addition of the resin adhesive and is unsuitable for applications at temperatures above the resin decomposition temperature but below the melting point of the fiberglass. There has been some use of adhesives to bond resinous fibers in clothing fabrics; however, this use has been limited because of the rigidity in the product caused by the adhesive. There are many other examples of the use of adhesives to bond intersecting fibers and all have the disadvantages of increased cost and the limitations imposed by the characteristics of the adhesive.

Because of the disadvantages encountered when adhesives are used, the prior art has mainly relied upon the weaving of fibers to form a fabric. However, in general, these woven fabrics have a tendency to come apart completely when an individual fiber is severed. This is particularly seen in the case of conventional nylon stocking fabric. In this instance when a fiber is severed a run develops along the entire length of the stocking. Thus, the conventional woven fabrics do not have the advantage of the resinous adhesive bonded fabrics of not coming apart when a fiber is severed.

The prior art has attempted to prevent the fabric from coming apart when a fiber is severed by the use of special knitting techniques. This is particularly seen in the case of nylon stocking fabrics where nylon fibers are woven through the fabric in order to knot the fabric and thus prevent runs. About 25% by weight more nylon fiber is used in these run proof nylon stocking fabrics in comparison to the conventional nylon stocking fabrics and thus, they are more expensive than the conventional nylon stocking fabrics because of increased material, labor and equipment costs. Further, because of the increased amount of nylon fiber used to make them run proof, they are less sheer and as a result less aesthetically pleasing than the conventional nylon stocking fabrics. Other fabrics made in this manner suffer from the same disadvantages where cost and sheerness are important factors.

It is therefore an object of the present invention to provide a method of fiber intersection bonding which eliminates the need for an adhesive or special knitting techniques.

Further, it is an object of this invention to provide novel fiber intersection bonded fabrics and in particular preferred novel nylon stocking fabrics which are comparable to the conventional nylon stocking fabrics in sheerness and amount of nylon fiber used.

Further still, it is an object of the present invention to provide a simple, economical method of fiber intersection bonding.

Further still, it is an object of the present invention to provide novel and inexpensive intersection bonded fabrics and in particular preferred nylon stocking fabrics.

These and other objects will become increasingly apparent to those skilled in the art by reference to the following description and drawings.

In the drawings:

FIGURE I is a front view of two intersecting fibers illustrating their unbonded contact before being bonded by the method of the present invention.

FIGURE II is a front view of the two intersecting fibers illustrated in FIGURE I illustrating the bond between the fibers after being bonded by the method of the present invention.

FIGURE III is a plan view of a conventional nylon stocking fabric illustrating the bonded fiber intersections after being bonded by the method of the present invention.

FIGURE IV is a plan view of a conventional nylon stocking fabric illustrating the randomly bonded fiber intersections after being bonded by the method of the present invention.

FIGURE V is a front view of a photoflash lamp used in the preferred equipment used in the method of the present invention and particularly illustrating the preferred helical configuration of the photoflash lamp tube.

FIGURE VI is a schematic diagram of a photoflash lamp and actuating circuit and illustrating the preferred equipment used in the method of the present invention.

More particularly, this invention relates to the use of a light pulse to accomplish contacting fiber bonding. Upon exposure to a light pulse contacting fibers are heated sufficiently to cause them to bond. In accord with the present invention, the fibers may or may not be pretreated to make them more bondable by the light pulse. Further, novel fiber intersection bonded fabrics, in particular preferred nylon stocking fabrics, are produced by the method of the present invention.

FIGURES II–IV illustrate the bonding effect of a light pulse upon intersecting and contacting fibers. Two intersecting and contacting fibers **11** and **12** as shown in FIGURE I are provided and are exposed to a light pulse in accord with the method of the present invention. FIGURE II illustrates the intersection bond **13** resulting when the fibers **11** and **12** are exposed to a light pulse in accord with the method of the present invention. FIGURE III illustrates a conventional nylon stocking fabric which has been subjected to a light pulse to form a bond **21** between intersecting and contacting nylon fibers **20** in accord with the present invention. FIGURE IV illustrates a conventional nylon stocking fabric which has unbonded fiber intersections **23** and randomly distributed bonded fiber intersections **22** between intersecting nylon fibers **24** after being selectively exposed to a light pulse in accord with the method of the present invention.

There are various means for creating a light pulse. The preferred equipment utilized in the process of the present invention to create a light pulse includes a photoflash lamp whose construction has been previously reported in the art. A particular photoflash lamp is illustrated in FIGURE V. In its simplest form, it consists of a transparent tube **14**, such as a quartz tube, which has electrodes **15** sealed through its ends. This tube **14** can have essentially any desired configuration. For example, the tube **14** may have a coiled or helical configuration as in FIGURE V. The size and configuration of the tube **14** depends primarily on the application. The tube **14** is filled with a gaseous material **16**.

The preferred gases are those which do not yield products that react with the inner surfaces of the photoflash lamp, such gases being xenon or argon, for example, which are classified among the rare gases in the periodic table of elements. The gaseous material is generally maintained at less than atmospheric pressure within the photoflash lamp.

FIGURE VI illustrates a schematic circuit incorporating a photoflash lamp **17**. A capacitor bank C_1 which is in parallel with the photoflash lamp **17** is connected across a high voltage direct current (D.C.) power supply V_1, supplied by a 115 volt alternating current source, as shown in the FIGURE VI. A suitable series resistance R_1 is inserted between the capacitor bank C_1 and the power supply V_1 to limit the charging current.

During operation, the capacitor or capacitor bank C_1 is charged to the desired high voltage by the high voltage D.C. supply V_1. The trigger switch S is then closed, causing a high voltage pulse to be delivered to the trigger wire **18** which is in the vicinity of the lamp **17**. This trigger pulse causes sufficient ionization of the gas within the lamp **17** to allow the storage capacitor C_1 to discharge its energy through the lamp **17** creating an intense light pulse.

In practice, the lamp **17** may be operated either above or below its hold off voltage. The hold off voltage is defined as the potential above which the gas breakdown in the lamp **17** occurs spontaneously. Thus, when the hold off voltage is exceeded, spontaneous breakdown of the gas allows the capacitor bank C_1 to discharge its energy through the lamp **17** without the use of the external trigger pulse circuit **19**. When operating above the hold off voltage, an electronic switch (not shown) must be inserted in the circuit so that, upon actuation, it will connect the lamp **17** across the capacitor C_1 at the desired firing time, thus allowing the stored electrical energy to be discharged through the lamp **17** upon command.

Below the hold off voltage, it is necessary to produce sufficient ionization of the gas within the lamp **17** to allow the breakdown process to proceed. In the preferred equipment, this is accomplished by a high voltage pulse produced in the external circuit **19** having a trigger wire **18** in the close vicinity of the lamp **17**. This high voltage trigger pulse is induced in the secondary winding of a high turns-ratio transformer T by discharging a small capacitor C_2 through the primary supplied by a D.C. positive battery at B^+. Suitable resistances R_2 and R_3 and grounds G_1, G_2, G_3 and G_4 are provided, as shown in FIGURE VI.

Alternative means of initiating the required ionization below the hold off potential involve the use of radio frequency sources, microwave sources, Tesla coils, or other sources of ionizing radiation, such as radioactive materials. The desired source of ionizing radiation needs only to be operated in the close vicinity of the lamp to be effective.

The light originates in the recombination, de-excitation and deceleration processes involving electrons within the plasma created by passing a high electrical current through the gas within the lamp. The spectrum observed outside the lamp is limited by the spectral transmission of the quartz or other material used in the tube wall. It may be further limited, if desired, by surrounding the tube with a jacket containing a liquid or other material having the desired light filtering characteristics. When limited only by the quartz tube wall, the light extends from the ultraviolet through the visible and into the infrared regions of the electromagnetic spectrum. Under the conditions of operation described here, the observed light has lost most of the spectral qualities characteristic of the emission spectrum of the particular gas inside the lamp; therefore, the effects of the light are essentially independent of the gas being used.

The intensity of the emitted light is dependent upon the amount of electrical current flowing through the lamp. The total light energy emanated during a single pulse of electrical current through the lamp is approximately proportional to the quantity of electrical energy dissipated in the lamp during the pulse. The light energy input to the lamp per pulse is easily determined by the formula: $E=\frac{1}{2}CV^2$ when E is the energy in watt seconds (joules), C is the capacitance in microfarads and V is the voltage in kilovolts.

The time required for the capacitor bank to discharge its energy through the lamp is a function of the characteristics, i.e., the resistance, inductance and capacitance, of the discharge circuit. Also, it is a function of the voltage across the capacitor bank. Thus, a higher voltage shortened the duration of the pulse. The duration of the pulse also was lengthened by increasing the capacitance or by increasing the inductance, and it was shortened by decreasing either of these quantities. The discharge characteristics of the circuit are described mathematically using known electrical equations.

In the present system, various inductances were connected in series with the lamp to provide an additional parameter which was varied to control the duration of the light flash. Ordinarily, the light flash was adjusted from a few hundred microseconds duration to a few milliseconds. Thus, the same lamp was operated at high power when the stored electrical energy was discharged in a relatively short time, i.e. of the order of hundreds of microseconds, or at lower power when the same quantity of electrical energy was discharged over a longer time interval, i.e. of the order of milliseconds.

Various conventional means were utilized to focus the available light energy on a particular object or region. This was partly accomplished by shaping the lamp to a configuration that best illuminates the object or region of interest. Additional focusing was accomplished by the use of mirrors or reflecting surfaces to direct the light toward the desired location. For example, a coiled or helical lamp was surrounded by a cylindrical polished aluminum reflector in order to concentrate most of the available light along the axis of the lamp helix. This significantly increased the light intensity available within the cylindrical core of the helix, permitting more efficient use of the lamp output at a given energy.

All of these techniques and improvements involving production, control and focusing of the high intensity light pulses are suitably employed in carrying out the process of this invention.

The basic equipment and principles in the area of light pulse heating are set forth by L. S. Nelson. (Nelson, L. S., Intense Rapid Heating With Flash Discharge Lamps, Science, vol. 136, No. 3513, p. 296, April 27, 1962).

It will be appreciated that there are numerous other methods of producing a light pulse by chemical and mechanical means. In particular, this high intensity light pulse can be produced by the use of conventional photoflash bulbs, for example. All of these equipment variations for producing light pulses are contemplated within the scope of the present invention.

When the light energy emitted by the photoflash lamp in incident on the surface of an exposed object, part of the light is reflected by the surface and the remainder is either transmitted by the object or absorbed within the body of the object. The reflectivity is dependent upon the condition of the surface, the nature of the material exposed and the wave length of the incident light, as well as the angle of incidence. The absorptivity is dependent upon the nature of the material and the wave length of the light. The amount of light energy absorbed contributes to the overall energy of the irradiated specimen, thus tending to raise its temperature. If the light energy is absorbed in a time that is too brief to allow significant dissipation of the excess energy to the surroundings, the temperature rise will be controlled only by the specific heat of the absorbing body itself. Thus, the temperature rise for a given quantity or absorbed light energy will be greater for a body of small dimensions, having a correspondingly smaller mass, than for a body of the same material of larger dimension and, accordingly, a larger mass. It is also true that, since the amount of light absorbed depends upon the area of surface exposed to the light, certain geometrical shapes may attain higher temperature for a given light pulse than others, even though the mass of absorbing material is kept constant.

Another factor of importance is the thermal conductivity of the absorbing body. If the absorber is a poor heat conductor, the absorbed energy may heat one region of the absorber to rather high temperatures while other regions of the absorber farther away from the illuminated surface may be only slightly affected. Thus, the heating effect can be localized. Objects of this nature can be effectively heated in localized regions without the necessity of the very short duration, higher energy light pulses necessary to reach equivalent temperatures in good heat conductors, such as metals, having the same surface area to mass ratio. It will be noted that organic materials, such as nylon, have both low thermal conductivities and low specific heat values, allowing them to be significantly heated by exposure to relatively long duration, lower energy pulses of light. The temperatures available by this method are sufficient to volatilize and thermally decompose portions of the absorbing body.

Light pulses created by the above described preferred equipment were used in the method of the present invention to cause bonding between intersecting and contacting fibers. The light pulses heated the intersecting fibers sufficiently to cause them to bond. Organic and inorganic fibers of all types were bonded by the method of the present invention. The method of the present invention is particularly illustrated by the following examples wherein the preferred method of bonding nylon stocking fabric intersections is set forth. It will be appreciated, however, that these examples are only illustrative and that many different types of fibers both organic and inorganic were bonded by the method of the present invention. Illustrative are Examples I–VIII.

Example I

A sample of tan nylon stocking fabric (nylon 66 fiber, E. I. du Pont and Company, Wilmington, Delaware) was wrapped around the outside of a Pyrex test tube 1 inch in diameter such that the fabric was slightly in tension. This was done to make sure that the intersecting fibers were in contact. There were no runs or tears in the sample. The surfaces of the nylon fibers in the fabric were covered with a very thin coating of a resinous material in the manufacture of the hosiery to increase the snag resistance of the hosiery.

The sample was mounted in the center of a helical photoflash lamp (HH 103, made by Kemlite Labs, Inc., Chicago, Illinois) such as that shown in FIGURE V and the circuit shown in FIGURE VI was used. The lamp was surrounded by a cylindrical aluminum reflector, the cylindrical axis of the lamp and reflector being in line. The dimensions of the lamp were as follows:

Outside diameter helix tube	2 5/16 inches.
Inside diameter helix	1½ inches.
Tube diameter	7/16 inch O.D.
Turns	5.
Helix length—long axis	3 inches.

The aluminum reflector used had a length of 7 3/16 inches, a diameter of 4 inches and its interior surface was polished and anodized to a mirror finish. The lamp contained xenon gas at less than atmospheric pressure and was constructed of a clear fused quartz with a wall thickness of approximately 1½ to 2 millimeters. A cylindrical quartz tube was positioned between the sample and the lamp in order to protect the lamp from contamination.

The lamp was connected to a 90 microfarad capacitor bank and the D.C. voltage was adjusted to 5.25 kilovolts. The trigger circuit was actuated resulting in a light pulse which in turn illuminated the specimen. The energy input to the lamp was about 1,240 joules.

After exposure the nylon fabric sample was checked microscopically and it was found that almost all of the fiber intersections were bonded. The intersection bonded product is illustrated in FIGURE III. The bond between the fiber intersections was relatively strong. It was found that a run could be initiated in the sample only with difficulty. When a cut was made in an untreated control sample, numerous runs were easily created along its length.

Example II

An uncoated sample of tan nylon stocking fabric (nylon 66 fiber) was placed between a pair of conventional glass microscope slides in order to insure that the fiber intersections were in contact. The sample was free from runs and tears. The sample and slide combination was positioned in the center of the helical tube used in Example I. The equipment and procedure of Example I was used.

The lamp was connected to a 36 microfarad capacitor bank and the D.C. voltage which was adjusted to 9 kilovolts. The trigger circuit was actuated causing a light pulse which in turn illuminated the specimen. The energy input to the lamp was about 1,458 joules.

After exposure, the sample was checked microscopically and it was found that almost all of the fiber intersections were bonded. The product is illustrated in FIGURE III.

Example III

An uncoated sample of tan nylon stocking fabric (nylon 66 fiber) was placed between a pair of microscopic slides as in Example II. The sample was free from runs and tears. The procedure and equipment of Example II was used. The lamp was fired at 5.5 kilovolts with a 90 microfarad capacitor in the circuit which resulted in a light pulse which illuminated the specimen. The energy input to the lamp was about 1,364 joules.

After exposure, the sample was examined microscopically and it was found that almost all of the fiber intersections were bonded. The product is illustrated in FIGURE III. The fiber intersection bonds were relatively strong. A cut was made in the sample and an attempt was made to create a run. It was found that upon pulling the cut, the run resistance as compared to an untreated control was significantly improved.

In certain instances, the fiber intersections were treated with various materials in order to increase the heating effect at the fiber intersections and to localize the heating at this point. Illustrative are Examples IV–VIII, wherein the nylon stocking fabrics are pretreated before being exposed to a light pulse in accord with the present invention.

Example IV

An uncoated sample of tan nylon stocking fabric (nylon 66 fiber) was wrapped around the outside of a Pyrex test tube 1 inch in diameter such that the fabric was in tension. This was done to make sure that the intersecting fibers were in contact. The fabric had been previously treated with a 1% by weight carbon black in water dispersion and air dried. The sample was free from runs or tears.

The sample was mounted as in Example I and the same photoflash lamp and circuit was used. A 90 microfarad capacitor bank was placed in the circuit and the voltage was adjusted to 3.5 kilovolts. A light pulse was initiated, by actuating the trigger switch, which illuminated the specimen. The energy input to the photoflash lamp was about 551 joules.

The sample was examined microscopically and it was found that almost all of the fiber intersections were bonded. The product is illustrated in FIGURE III. When a cut was made in the sample, it was found that the cut only became larger upon pulling and the characteristic nylon stocking fabric run did not deevlop. Further, it was found that the fiber intersections were strong and not easily separated.

Example V

An uncoated sample of light tan nylon stocking fabric (nylon 66 fiber) was treated with benzyl alcohol. The sample was free from runs and tears. The wetted sample was then stretched and retained over an anodized polished aluminum surface. This was done to make sure that the fiber intersections were in contact. The sample, benzyl alcohol and sample holder were clean. The specimen was mounted adjacent to a quartz shield which in turn was adjacent to the inner surface of a helical photoflash lamp (HH 500–1, made by Kemlite Labs., Inc., Chicago, Illinois) having the following characteristics:

Outside diameter helix	6⅛ inches.
Inside diameter helix	5 inches.
Tube diameter	9/16 inch O.D.
Turns	7.
Helix length—long axis	4 inches.

A polished and anodized cylindrical aluminum reflector 8 inches long and 7 inches in diameter was positioned around the photoflash lamp as in Example I. The circuit illustrated in FIGURE VI and the procedure of Example I was used.

The specimen was illuminated by 5 light pulses with the voltage set at 7.25 kilovolts with a 198 microfarad capacitor bank and a 10 microhenry inductance added to the system. A total of about 5,200 joules of energy was put into the lamp per pulse. The combined total energy for the 5 light pulses was about 26,000 joules.

After exposure, the sample was vacuum dried to remove any remaining benzyl alcohol and then examined microscopically. It was found that the fiber intersections were completely bonded and the product is illustrated in FIGURE III. The fiber intersection bonds were very strong and not easily separated. When a cut was made in this sample, it was found that the cut only became larger upon pulling and the characteristic stocking fabric run did not develop.

Example VI

An uncoated tan nylon stocking fabric (nylon 66 fiber) was mounted on a circular hoop and stretched until it was taut. This was done to be sure that intersecting fibers were in contact. The sample was free from runs and tears. The sample was then treated with a colloidal silica-water dispersion and allowed to air dry.

The procedure and equipment of Example I was used. The photoflash lamp was fired at 7 kilovolts with a 90 microfarad capacitor bank and with a 200 microhenry inductance in the system thereby creating a light pulse which illuminated the specimen. The energy input to the lamp was about 2,205 joules.

After exposure, the sample was examined and it was found that fiber intersections were bonded, although they were relatively easily separated when stressed.

Example VII

An uncoated tan nylon stocking fabric (nylon 66 fiber) was used as well as the equipment of Example V. The sample was free from runs and tears. The sample was mounted on a circular hoop and pulled taut. This was done to make sure that the intersecting fibers were in contact. The sample was then treated with a 1.0% by weight of finely divided carbon black dispersed in 99.0% by weight of a 75/25% mixture by weight, respectively, of water and denatured ethanol and air dried.

The sample was exposed to a light pulse with the voltage set at 5 kilovolts with a 90 microfarad capacitor bank and with a 200 microhenry inductance in the system. The energy input to the lamp was about 1,125 joules.

After exposure, the sample was examined microscopically and it was found that some of the fiber intersections were bonded. However, not all of the fiber intersections in the sample were bonded. The fiber intersections were bonded in a random manner as illustrated in FIGURE IV.

Example VIII

An uncoated tan nylon stocking fabric (nylon 66 fiber) was mounted on a holder and backed with an anodized and polished aluminum reflector such that the sample was in tension and in contact with the reflector. This was done to make sure that the fiber intersections were in contact. The sample was free from runs and tears. The sample was then saturated with benzyl alcohol. The sample was then mounted in contact with the surface of a perforated (1/16 inch diameter) aluminum shield (1/16 inch spacing). The shield was positioned such that no one vertical nylon row in the sample would have all of its intersections exposed to the light pulse. The sides and back of the holder were shielded by an aluminum shield to prevent carbonization of the benzyl alcohol on the sides and back of the holder.

The equipment of Example V was used. The specimen was exposed to a light pulse at 9 kilovolts with a 198 microfarad capacitor bank and a 10 microhenry inductance in the system. The sample was subjected to 4 more light pulses under the same conditions. The input to the lamp per pulse was about 8,019 joules or a total of about 40,095 joules.

After exposure the sample was examined. It was found that the fiber intersections exposed to the light pulse, and not shielded by the pieces of aluminum foil, were strongly bonded and not easily separated. The nylon stocking fabric with the randomly bonded fiber intersections is illustrated in FIGURE IV. When a cut was made in the sample, it was found that the hole only became larger upon pulling and the characteristic nylon run did not develop. Further, it was found that the sample had almost the identical texture and feel of an untreated control sample.

The shielding of some of the fiber intersections from the light pulse in order to prevent bonding, as in Example VIII, is preferred under certain conditions and when treating certain fabrics. In particular, with the nylon stocking fabrics, it was found advantageous to bond the nylon fiber intersections at random. The result of this method of bonding is illustrated in FIGURE IV. It was found that in this instance, the fabric retained the texture and feel of the conventional untreated nylon stocking fabrics as well as retaining most of the elasticity. Thus, this procedure is preferred when treating nylon stocking fabrics.

Examples I and IV–VIII illustrate the use of a variety of different methods of pretreatment of the fibers to make them more bondable. Thus, benzyl alcohol, carbon black and colloidal silica were used in these examples. It will be appreciated that there are many other materials both organic and inorganic which may be used to facilitate the bonding of the fiber intersections. Particular examples are heated water or steam which causes resinous fibers to "blush" and make them more light absorptive; various metal oxides and sulfides which readily absorb light and thus are heated by the light pulse and in turn heat the surface of the fiber; thin resin coatings on the fibers which are heat catalyzed or polymerized; resin coatings on the fibers which are heated by the light pulse to their fusion temperature, and the like. All of these pretreatments of the fibers to make the fiber intersections more bondable are within the scope of the present invention.

It is preferred to use a liquid pretreatment of the fibers as in Examples IV–VIII. When a liquid was applied to a fabric, such as the nylon stocking fabric, it was found that the liquid had a tendency to accumulate at the fiber intersections, leaving other areas of the fabric relatively unwetted. When the fabric was exposed to a light pulse the light energy was selectively absorbed at the fiber intersections and they were heated to a higher temperature than the other areas of the fabric. The original characteristics of the fabric in areas other than the fiber intersections were retained because of their relatively smaller absorption of energy from the light pulse. It was found that the liquid pretreatment of Examples IV–VIII was preferred for this reason.

It will be appreciated that the pretreatment of the fibers is not necessary in order to accomplish fiber intersection bonding. This is seen in Examples II and III. However, it was found that the fiber intersections were more readily bonded by the use of various pretreatments, particularly those shown in Examples IV–VIII.

It will be appreciated that there are many types of fibers which can be bonded by the process of the present invention. Thus, for example, inorganic fibers, such as glass and metal fibers (aluminum, iron, copper and the like), can be bonded by the method of the present invention. Further, organic fibers composed of the various vinyl, epoxy, acrylic, urethane, polyester and nylon resins, for instance, can be bonded by the process of the present invention. All of these variations in fiber composition are within the scope of the present invention.

It will be appreciated that it is preferred to have the fibers intersecting as well as contacting as shown in Examples I–VIII. However, the fibers can be positioned such that they are in contact in other ways. Thus, the fibers can be butt joined (end to end) or spliced in an angular or scarfed manner with or without pretreatment as shown in Examples I–VIII. Thus, for instance, butt joints were made in 0.018 inch diameter nylon 6 and Dacron polyester monofilaments by applying a very thin layer of graphite to one of the ends of the mating surfaces to be butt joined, contacting the mating surfaces and positioning the fibers to be joined such that they share a common long axis and subjecting them to a light pulse while maintaining the butt joined fibers in this position. All of these variations are intended to be within the scope of the present invention.

It will further be appreciated that the method of the present invention can be conducted on a continuous basis. By using the proper power supply circuitry 10 or more light pulses per second can be created. In this case, a moving sheet of fabric can be continuously illuminated by the light pulses. Further, multiple photoflash lamps can be used to increase the illumination of the fabric. All of these equipment variations are within the skill of the art and are within the scope of the present invention.

The novel articles of manufacture produced by the method of the present invention have great utility. This is particularly true of the intersection bonded nylon stocking fabrics of the present invention. Thus, for instance, nylon stocking fabrics can be made run-proof by the method of the present invention without decreasing the sheerness of the product. Further, the texture and feel of the product is comparable to the untreated conventional nylon stocking fabrics.

In the manufacture of nylon stockings from seamless nylon tubes, the tubes are mounted on forms and treated to form the shape of the leg. While the stockings are on these sizing forms, they can be treated by the method of the present invention to cause intersection bonding. The helical photoflash lamp can easily be positioned around the form and enlarged to the proper size. Thus, the method of the present invention is easily adaptable to the conventional method of manufacture of nylon stockings.

It will be appreciated that non-woven fabrics can be made by the method of the present invention. Thus, if overlapping rows of intersecting fibers are positioned in contact with each other, novel non-woven fabrics can be prepared by the method of the present invention.

A primary advantage of the method of the present invention is that the fibers are subjected to a very transient heating effect due to the very short duration of the light pulse. Thus, the fibers are not destroyed by this heating. If the fibers were subjected to longer periods of heating using conventional heating equipment at the temperatures necessary for the fusion of the fibers, they would be destroyed or permanently damaged. The process of the present invention provides a method of retaining the characteristics of the original fiber.

An added effect derived from the process of the present invention is that there is a delustering of the resinous fibers in certain instances. Many resinous fibers have a definite luster. Thus, when the fibers were treated with a light pulse under conditions such that the heat was not rapidly dissipated from the fiber, the sheen or luster on the surface of the fiber was reduced or eliminated. Thus, for instance, nylon stocking hosiery can be delustered in this manner.

It will be appreciated that the foregoing description is only illustrative of the present invention and it is intended that this invention be limited only by the hereinafter appended claims.

I claim:

1. The method of bonding contacting fibers comprising an organic resin at least at the point of contact of the fibers, which comprises:

(a) mounting a high energy light pulse source such that a light pulse from the light pulse source will irradiate the point of contact of the fibers positioned in spaced relationship to the light pulse source; and

(b) exposing the point of contact of the fibers to a light pulse from the light pulse source of between about a few hundred microseconds to about a few milliseconds duration and of sufficient energy to cause bonding of the fibers at the point of contact.

2. The method of claim 1 wherein the light pulse source is a photoflash lamp comprising a transparent tube containing a rare gas sealed within the tube, powered by a high voltage direct current source, and by a capacitor which is charged by the direct current source.

3. The method of claim 2 wherein the duration of the light pulse is regulated by an inductance coil placed in series with the photoflash lamp.

4. The method of claim 3 wherein the light pulse is obtained from a cylindrically constructed photoflash lamp, wherein the contacting fibers are placed inside the cylinder formed by the photoflash lamp and wherein cylindrical reflector means are positioned around the outside of the photoflash lamp so that the longitudinal axis of the photoflash lamp and reflector means are coextensive, so that a light pulse from the photoflash lamp is reflected to the inside of the cylinder formed by the photoflash lamp to irradiate the fibers at their point of contact.

5. The method of claim 1 wherein the light source is mounted with a reflector to increase the amount of the light pulse which is directed to the point of contact of the fibers from the light source.

6. The method of claim 1 wherein the fibers at least at their point of contact are pre-treated with a light absorbing material which increases the absorption of light energy at the point of contact of the fibers over the normal absorption of light by the untreated fiber surface.

7. The method of claim 1 wherein the fiber is composed of an organic resinous material.

8. The method of claim 7 wherein the resinous material is nylon.

9. The method of claim 8 wherein the contacting fibers are present in nylon stocking material.

10. The method of claim 9 wherein the nylon stockings are exposed to the light pulse while on stocking sizing forms.

11. The method of claim 10 wherein some of the points of contact of the fibers in the nylon stockings are shielded from the light pulse to prevent bonding.

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