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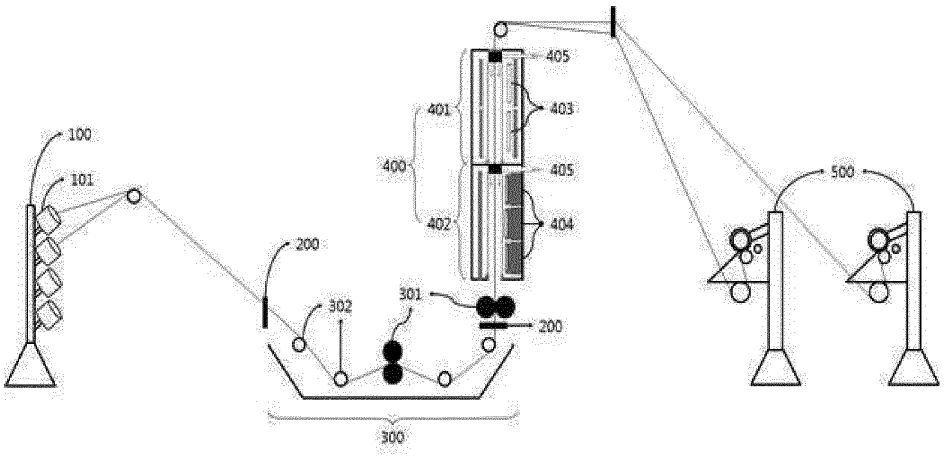
(54) **METHOD FOR HIGH FASTNESS DYEING OF FIBROUS YARN EMPLOYING UV CURING**

(57) Disclosed herein is a method wherein the yarns ranging from a common fiber for the purpose of clothes to a hard-to-dye fiber are impregnated in a UV ray-cured coating liquid, thus forming a thin film coating layer and then curing a UV ray-cured coating liquid. As compared to a conventional thermosetting yarn coating method, the present invention is providing an environmentally friendly manufacturing method in the way that about 90% energy saving effect can be obtained, and waste water is not produced since a medium, for example, water, etc. is not used, and carbon dioxide is not emitted during combustion, and a washing process can be removed with the aid of a high conversion degree. Various functional substances may be distributed with a good adhering force, thus providing various performances.

Figure 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a dyeing method using a UV ray curing method which may be used irrespective of materials from a common clothes fiber to an industrial fiber the color revelation of which is difficult, in a color formation method wherein any medium is not used in a wet dyeing method using a medium, for example, water or a solvent. The present invention relates to an environmentally friendly dyeing method.

BACKGROUND ART

[0002] As concerns about an environmental change, for example, a water shortage, an expanding desert area, a rising sea level, etc. due to a resource depletion of coal, petroleum, etc. and a global warming phenomenon due to an industrialization are increasing, an alternative energy exploration, a fuel efficiency enhancement, a saving of water and energy uses are being considered a key national policy, and many countries are trying to reduce any factors which might have an effect on the harming of natural environments. In these environment regulation enhancement policies in Korea and foreign countries, a dyeing process and a wet process account for about 70% of the total energy and water consumption in the whole fiber industries. For this reason, the certified emission reduction in the fiber industry and any load in terms of water shortage are increasing.

[0003] The color revelation process of the fiber is formed of a dope dyeing process wherein a dye is added to a material during the manufacturing of a fiber, a high temperature dyeing process wherein a dyeing is carried out in a yarn or woven fabric, and a coating process wherein a preparation is carried out with a pigment and a dye. The method for a color formation with the aid of a dope dyeing is a method wherein a solid state fiber, for example, a regeneration, a semi-synthesis, a synthetic fiber, etc. except for a natural fiber is transformed into a liquid state through dissolution or melting, and pigment is added. In case of a natural fiber or a heat resistance and high performance fiber, a phase change is very hard, and a discoloring problem may occur due to a rough condition for a phase change. Since the number of colors is limited, such a method is employed only for a special case. Moreover, the use thereof is very limited due to a high cost.

[0004] Furthermore, the high temperature dyeing process is a most common process wherein a dye penetrates in a non-crystal region of a fiber formed of polymers, and a color can be revealed through a reaction or absorption. Here, in addition to the dye, a chemical, for example, a levelling agent, an additive, and acid or alkali regulator will be added, and a high heat is necessary for the sake of easier penetration of dye, thus revealing a desired color. If it is assumed that a fiber material is formed of one component, the above mentioned method would be a very useful method. In case of a yarn or raw fabric wherein other fiber materials are combined, a dye selection, a dyeing process and a post-process condition may change for each fiber material. For this reason, a lot of water is used, which may result in a big economical load with respect to the process of waste water.

[0005] Moreover, the color coating process may have an advantage in terms of a low cost and various color revelations thanks to a conventional high temperature heat hardness, but a friction fastness is very weak due to a failure in an adhering force between a fiber and a coating liquid, and a high temperature heat should be used for a heat melting of a resin or an impregnation of a low viscosity resin and a heat hardness method, whereupon a lot of problems may occur during the process, which may cause a slow production, thus resulting in a low possibility for mass production.

[0006] Among the common fibers used as a clothes fiber, a cotton, a wool, a hemp cloth, etc. are natural fibers, and a rayon fiber reproduced through a chemical change in terms of the natural fiber may be classified as a regenerated fiber. As a synthetic fiber, there are a polyethylene terephthalate (PET), a polyethyleneterephthalate (PTT), a cation dyeable PET (CDP), a nylon, an acrylic fiber, a spandex fiber, etc. The cotton, hemp cloth, rayon, etc. which are the cellulose natural fiber can be color-revealed with a reactive dye, and a wool, silk, and nylon fiber can be color-revealed with an acid dye, and an acryl and modacryl fiber can be color-revealed with a cation dye, and a PET fiber can be color-revealed with a distribution dye. These methods are carried by a high temperature dyeing method, and the colors can be revealed based on each dyeing condition.

[0007] The fibers used for the purpose of industry are fibers with enhanced physical properties, heat resistance or other functions. Since such fibers cannot be easily color-revealed using a dye, other additives, heated water, etc., they are called a hard-to-dye fiber.

[0008] The above problems in general occur due to the lack of the penetration and durability of dyes since the fiber polymer is formed of strong polymer chains or is formed in a chemical structure which cannot react with dyes. As these fibers, there are polyethylene (PE) and polypropylene (PP) fibers, and as a high performance industrial fiber, there are glass fiber, ultra high molecular weight polyethylene (UHMWPE), aramid fiber, carbon fiber, polyimide (PI), polybenzoxazole (PBO), polybenzimidazole (PBI), etc. which belong to a high strength, high heat resistance fiber, so such fibers are generally used for the purpose of industry rather than the purpose of clothes due to the above-mentioned problems.

[0009] In case of the glass fiber, the physical properties of the targeted product may change in accordance with

components. If dye or pigment is mixed in silica, which is a main ingredient, during the crude liquid coloring process for the sake of color revelation, the color revelation may not be carried out since it is impossible to estimate any change in a product's physical property. In the PE, PP fibers which are polyolefin fibers, there is not any functional group which may react with dyes, so color revelation is hard. In case of a high performance fiber, for example, a UHMWPE, aramid, PBO, PBI, etc., since a polymer structure and a non-crystal region are minimized, the penetration of dyes is not easy, so color revelation becomes harder. In addition, since carbon fiber is formed of only carbons in structure through a carbonization process, the fiber itself is a deep shade black, so color revelation may not be carried out.

[0010] For the UHMWPE among the hard-to-dye fibers, a new dye has been developed since a color revelation was difficult with commercially available dyes. More specifically, the color revelation can be possible through a dyeing process wherein a superhydrophobic dye is synthesized by substituting an alkyl group, which is similar with a fiber polymer, with a base component of a conventionally available dispersion dye.

[0011] However, any change in the physical property of the fiber itself may be caused during the dyeing process wherein a high temperature heat water is used because of a low heat resistance of the fiber itself, and the mass production and commercialization of dyes are impossible, so the above newly developed dye may not apply to other hard-to-dye fibers, thus making difficult the further development thereof. Therefore, it is necessary to invent a new color revelation process with respect to the hard-to-dye fiber on which it is difficult to form dyes through a crude liquid coloring process or a dyeing process which belong to the conventional color revelation processes. The color revelation should be carried out under a condition where the change of natural physical property of the fiber is small, and commercialization is easy, and cost is low.

[0012] Moreover, as a customer's awareness on safety in terms of an industry and life environment is increasing in Korea and throughout the world, a high visibility color formation on a fiber product is attracting a big attention, wherein such a product is able to provide a good visibility at night, whereupon the development of such products is underway. For a high visibility fiber product market, a high visibility color formation process is being developed using a fluorescent dye for the sake of application to a clothes fiber, for example, a modacryl, PET, nylon, etc. as well as an industrial fiber, for example, UHMWPE, aramid, etc. but the actual application is limited due to the problems, for example, a discoloration due to sunshine and a low visibility and a limit to the number of colors. In case of the market of working clothes in Europe, even though the performance ranges on yellow, red and orange colors which may determine a high visibility are suggested, it is impossible to obtain a high visibility through a high temperature dyeing method using a dye.

[0013] In recent years, as a leisure life, an outdoor life and an awareness on safety is increasing, fiber product customers tend to need a high visibility, high function or high performance fiber material. For this reason, a clothes fiber is not used alone. More specifically, two or more than two clothes fiber materials are used together or a blended product of a clothes fiber material and an industrial fiber material is used a lot. In this case, the dyeing process may become complicated, and the use of water will increase, which results in the increased amount of waste water. For this reason, the use of the industrial fiber material is limited. Given the above described situation, the coating process may be most preferred so as to reveal a desired color irrespective of the kinds of materials.

[0014] The thermosetting process among the color revelation processes, as mentioned above, has a problem in terms of the durability of a coating layer due to a friction, and productivity. In order to resolve the problems of a heat sensitive material, a color may be coated on a fiber using a UV ray curing method. Since the UV ray curing method can be carried out in seconds or minutes, the productivity can be enhanced, and the fastness against friction can be increased with the aid of a smooth surface formation. This method can be employed to a heat sensitive fiber material.

[Prior Art Documents]

[Patent Documents]

[0015]

(Patent Document 1) Korean Patent Laid-open No. 10-2011-0101755 (published on September 16, 2011)
(Patent Document 2) Korean Patent Laid-open No. 10-1383087 (published on April 8, 2014)

DISCLOSURE OF THE INVENTION

[0016] Accordingly, it is an object of the present invention to provide an environmentally friendly manufacturing method and a high fastness dyeing method which is able to provide a good adhering performance wherein the present invention is a high fastness thin film color coating technology for a hard-to-dye industrial fiber as well as a common fiber which is able to provide about 90% of an energy saving effect as compared to a conventional thermosetting yarn coating method, and a medium, for example, water, etc. is not used, and waste water does not generate, and a water washing process can be removed while providing a non-emission of carbon dioxide during a combustion and a high degree of conversion.

[0017] To achieve the above object, there is provided a high fastness dyeing method of a fiber yarn using an ultraviolet (UV) ray curing method, which includes, but is not limited to, preparing a UV ray-cured coating liquid mixed with a coloring, a UV ray-cured type monomer, a UV ray-cured type oligomer and a photo initiator, wherein the UV ray-cured coating liquid is mixed with 0.4~1% by weight of coloring, 90~98.5% by weight of UV ray-cured type monomer, 1~8% by weight of UV ray-cured type oligomer, and 0.1~1% by weight of a photo initiator; impregnating a fiber yarn into the UV ray-cured coating liquid; forming a thin film coating layer on the surface of the fiber yarn in such a way to pass it through compressing rollers twice or more than twice with a predetermined pressure; and curing the UV ray-cured coating liquid by radiating the rays from a UV ray lamp and a LED of a wavelength range of 260~395nm under an inert gas environment while moving the coated fiber yarn in the direction vertical to the ground.

[0018] The present invention will be described in brief.

[0019] The method for dyeing a fiber yarn according to the present invention is a method wherein a yarn formed of a clothes and industrial fiber material is impregnated in a UV ray-cured coating liquid, and a thin film coating layer is formed, and a UV ray-cured coating liquid is cured. A pigment and a UV ray-cured type resin are mixed at a predetermined concentration for the sake of color revelation, and a UV ray is radiated, and the mixed liquid is cured, thus curing a fiber yarn the color of which has been revealed.

[0020] In the present invention, the fiber material which is a target of the thin film color coating may be formed of one or more than one fiber for the purpose of clothes selected from the group consisting of a cotton, a wool, a silk, a hemp cloth, rayon, acetate, PET, PTT, a cation dyeable PET (CDP), nylon, acrylic, and spandex fiber, and may be formed of any of or two or more than two fiber yarns for the purpose of industry selected from the group consisting of a glass fiber yarn, a polyethylene (PE) fiber yarn, a polypropylene (PP) fiber yarn, a ultrahigh molecular weigh polyethylene (UHMWPE) fiber yarn, an aramid fiber yarn, a carbon fiber yarn, a polyimide (PI) fiber yarn, a polybenzoxazole (PBO) fiber yarn, and a polybenzimidazole (PBI) fiber yarn. The above fibers are fibers the colors of which can be easily revealed without using heated water or any medium.

[0021] In the present invention, the UV ray-cured coating liquid for coating on the fiber yarn is a UV ray-cured coating mixed with 0.4~1% by weight of a coloring, 90~98.5% by weight of UV ray-cured type monomer, 1~8% by weight of UV ray-cured type oligomer, and 0.1~1% by weight of a photo initiator.

[0022] If the amount of UV ray-cured type monomer is smaller than 90% by weight, a problem may occur in the fastness due to a bad adhering force of the coating liquid, and if the amount thereof is greater than 98.5% by weight, a problem may occur in a color revelation and physical property due to the decrease amount of coloring or oligomer.

[0023] If the amount of the UV ray-cured type oligomer is smaller than 1% by weight, a color revelation may be difficult due to the decreased amount of coloring of the coating layer for a lower viscosity, and a tactile feeling may feel hard. If the amount thereof is greater than 8% by weight, a weaving performance may become bad since a thin film coating layer cannot be formed due to the increased viscosity.

[0024] It is preferred that the coloring of the UV ray-cured coating liquid may be a coloring which contains an inorganic or organic pigment, dye, ink, etc. which has a durability against discoloration with respect to UV ray.

[0025] Any of azo dyes, naphthol dyes, phthalocyanine, etc. may be used.

[0026] Moreover, it is preferred that the coloring is a high visibility coloring corresponding to one or more than one a fluorescent pigment, a fluorescent dye, and a fluorescent ink which have a durability against discoloration with respect to UV ray, thus enhancing visibility.

[0027] In case of the resin used in the UV ray-cured coating liquid, it is formed of an acrylate oligomer and a monomer which is a reactive diluent. The monomer and oligomer may be changed as follows based on the surface characteristic of the selected fiber material.

[0028] In the present invention, the UV ray-cured coating liquid used to process one or more than one selected from the group consisting of a glass fiber yarn, a polyethylene (PE) fiber yarn, a polypropylene (PP) fiber yarn, a ultrahigh molecular weight polyethylene (UHMWPE) fiber yarn, an aramid fiber yarn, a carbon fiber yarn, a polyimide (PI) fiber yarn, a polybenzoxazole (PBO) fiber yarn, and a polybenzimidazole (PBI) fiber yarn, which are hard-to-dye fibers, is preferably a UV ray-cured coating liquid mixed with 0.9~10% by weight of a coloring, 30~89% by weight of a UV ray-cured type monomer, 10~40% by weight of a UV ray-cured type oligomer, and 0.1~20% by weight of a photo initiator. If the amount of the UV ray-cured type monomer is smaller than 30% by weight, a problem may occur in fastness due to a weak adhering force of the coating liquid, and if the amount thereof is greater than 89% by weight, the content of a coloring or an oligomer decreases, and a problem may occur in a color revelation and a physical property. If the amount of the UV ray-cured type oligomer is smaller than 10% by weight, a color revelation may not occur due to the decreased amount of coloring of the coating layer due to a lower viscosity, for which the tactile feeling may feed hard, and if the amount thereof is greater than 40% by weight, the coating layer of the thin film may not form due to the increased viscosity, which results in the decreasing weaving performance

[0029] It is preferred that the ultraviolet ray-hareened type monomer among the ultraviolet ray-cured type coating liquid may be formed of one or more than one selected from the group consisting of methyl methacrylate, Isobonyl acrylate, Tetrahydrofurfuryl acrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate, n-butyl acr-

ylate, hexanediol diacrylate, etoxy etoxy ethylacrylate, and octadecyl acrylate.

[0030] The ultraviolet ray-cured type oligomer among the ultraviolet ray-cured type coating liquid may use one or more than one oligomer selected from the group consisting of polyurethane acrylate, epoxy acrylate, unsaturated polyester acrylate, vinyl acrylate, polyvinyl butyral and polymethylmethacrylate. The reason why various monomer and oligomer are used is that it needs to manufacture a mixed liquid which has a good adhesive strength with the coating layer and the fiber, and it needs to mix a coating liquid which has a physical property similar with the characteristic of the surface of the fiber.

[0031] It is preferred that the photo initiator among the ultraviolet ray-cured type coating liquid uses any one selected from the group consisting of benzophenone, Irgacure 184(1-Hydroxy-cyclohexyl-phenyl ketone), Irgacure 1173(2-Hydroxy-2-methyl-1-phenyl-1-propanone), Irgacure 907(2-methyl-1-[4-(methylthio)phenyl]-2-(4-morpholinyl)-1-propanone), Darocure TPO(Diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide), thus matching with the ultraviolet ray radiation wavelength.

[0032] With the aid of the thusly prepared materials, the weaving possibility of the color-coated yarn can be estimated based on the thickness of the coating layer. In order to coat the above UV ray-cured type coating liquid on a fiber yarn formed of 20 or more than 20 strands, 20 or more than 20 cones around which the yarn is wound with a predetermined weight are forced to penetrate into the inside of the fiber yarn by pressing a pressure to the compressing roller from a prepared creel, and the color costing film should be a uniform and thin film after the UV curing, and is wound around the winder devices provided by the number same as the above. It is preferred that the above step is carried out using a coating device as illustrated in the plane view of Figure 2.

[0033] The yarn coating device in Figure 1 may include a creel unit 100, a body 200, an impregnation unit 300, a compressing roller 301, a UV ray curing unit 400, and a winder device 500, and the fiber yarn is transferred from the creel unit to the winder device. At this time, it needs to transfer the fiber yarn without any tension since the fiber yarn 101 being transferred from the cone engaged to the creel unit might be cut by a tension during the transfer. The body 200 is shaped like a comb and is provided to prevent the tangling of more than 20 strands. Each fiber yarn is transferred via the guide roll to the impregnation unit which contains a coating liquid. The impregnation unit 300 should equip with grooves formed at regular intervals so as to prevent any tangling during the transfer of the fiber yarn if the guide roll 302 is used and may be substituted with the body 200. An impregnation condition of more than twice or for more than one minute with the aid of the compressing roller 201 having a predetermined pressure should be provided so as to penetrate the coating liquid into the inside of the fiber yarn in such a way to offset a surface tension at an interface between the coating liquid and the fiber yarn during the impregnation. A thin film coating layer is formed on the surface of the fiber yarn with the aid of the compressing roller before it reaches the UV ray curing unit 400. The compressing roller is provided for the mixed liquid to make a coating layer of a uniform thickness on the surface of the fiber yarn. The compressing roller provided to form a coating layer of a constant thickness is made of a flexible rubber or silicon material or a steel roll the pressure of which can be adjusted. The pressure adjustment of the compressing roller may be carried out to adjust the thickness of the coating layer formed on the surface of the fiber yarn. If the compression is carried with a high pressure, a too thin film may be formed or a non-coated portion may occur partially, for which the uniformity of color may be degraded. If the compressing is carried with a lower pressure, the coating layer may become too thick. In this case, the uniformity of the coating layer may be degraded due to the flow of the liquefied coating liquid after it is cured. For this reason, the weaving work with the coating yarn may be impossible.

[0034] Thereafter, an ultraviolet ray with a wavelength range of 260~395nm is radiated while the coated hard-to-dye fiber yarn moves in the vertical direction from the ground, thus curing the ultraviolet ray-cured type coating liquid. Here, it is preferred that the ultraviolet radiation is performed using a UV ray lamp curing unit 401 wherein one or more of Fe, Ga and Mg metallic substances is added to a mercury lamp, and an UV ray LED curing unit 402 which is able to radiate a UV ray of a longest wavelength (395nm). Since the curing of the coating layer can be carried out in seconds or minutes since the UV ray which has longer wavelengths than the mercury lamp or the metal halide lamp, thus enhancing the productivity. Since the curing can be carried out at a room temperature of 20~30°C if the radiation is performed using the UV ray LED, the present invention will be applied to a fiber material which is sensitive to heat.

[0035] In case of the UV ray curing, the curing speed may become slow due to a dissolution in the coating liquid after a radical polymerization and an oxygen inhibition operation wherein a stop reaction occurs for the presence of oxygen in the air during the curing process. As a method to enhance the curing speed, a device is required, which is able to remove any curing speed inhibition factor, for example, an oxygen inhibition operation, in such a way to flow an inert gas, for example, argon, nitrogen or carbon dioxide, into the UV ray curing unit.

[0036] Moreover, the infrared ray drying process may be performed by installing an infrared ray drying unit before or after the ultraviolet ray radiation process, which aims to improve the hardness by drying the contained moisture or through the dehydration of moisture in case where water soluble or water dispersion mixing liquid is used.

[0037] It is preferred that the process is carried out in the vertical direction with respect to the ground from the coating impregnation to the UV ray radiation process while transferring the fiber yarn of 20 or more than 20 yarns. This is carried out for the coated mixed liquid to make a constant thickness thin film after the impregnation and compressing roller

operations. If the designing is performed in a direction horizontal to the ground or a direction at a predetermined angle, the liquefied mixed liquid may have a flowing in the direction vertical to the coating moving direction due to the gravity, for which a circular formation phenomenon may occur along the yarn, thus inhibiting the formation of the thin film coating layer, whereupon it is impossible to weave for a desired use purpose. The thusly coated and cured fiber yarn is wound around a winder device which is provided in the same number as the inputted fiber yarns, thus finishing a high fastness dye yarn product.

INDUSTRIAL EFFECTS

[0038] The present invention is directed to an environmentally friendly manufacturing method and a high fastness dyeing method which is able to provide a good adhering performance wherein the present invention is a high fastness thin film color coating technology for a hard-to-dye industrial fiber as well as a common fiber for clothes which is able to provide about 90% of an energy saving effect as compared to a conventional thermosetting yarn coating method, and a medium, for example, water, etc. is not used, and waste water does not generate, and a water washing process can be removed while providing a non-emission of carbon dioxide during a combustion and a high degree of conversion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] The present invention will become better understood with reference to the accompanying drawings which are given only by way of illustration and thus are not limitative of the present invention, wherein;

Figure 1 is a side view illustrating a high fastness dyeing process of a fiber yarn wherein a UV ray curing method is employed according to the present invention;
Figure 2 is a plane view illustrating a high fastness dyeing process of a fiver yarn wherein a UV ray curing method is employed according to the present invention; and
Figure 3 is a chromaticity coordinate red graph of a fiber yarn of a fourth embodiment of the present invention.

MODES FOR CARRYING OUT THE INVENTION

[0040] The first embodiment of the present invention is directed to a non-limited example of the high fastness dyeing method of a fiber yarn wherein a UV ray curing method is employed according to the present invention.

[Embodiment 1]

[0041] A UV ray-cured coating liquid is prepared, which is mixed with 1% by weight of phthalocyanine organic pigment (blue), 85% by weight of methyl methacrylate monomer, 8% by weight of aliphatic urethane acrylate oligomer, 12% by weight of tetrahydrofurfuryl acrylate monomer, 2% by weight of 2-hydroxyethyl acrylate monomer, 0.5% by weight of benzophenone as a photo initiator, 0.3% by weight of irgacure 1173, and 0.2% by weight of darocure TPO. A polyethyleneterephthalate fiber yarn which is a common fiber for clothes is moved to the impregnation unit containing a coating liquid and is coated with a predetermined amount of the coating liquid and is subjected to two compressing rollers with a predetermined pressure (1 MPa), thus forming a thin film coating layer. The rays from the UV ray lamp and LED of a wavelength of 260~395nm are radiated under the nitrogen environment which is an inert gas in the direction vertical to the ground, and the liquefied coating liquid is cured at a speed of 50m/min by way of the photo curing method, and it is wound using a rewinding unit into a bunch shape, thus finishing the process. A result of the physical property of the dyeing of the polyethyleneterephthalate (PET) which is a common fiber for the clothes on which the coating work is finished is shown in Table 1.

Table 1

Evaluation Items	Units	Embodiment 1	Evaluation Method
1. Rate of change in tensile strength	%	+0.3	ASTM D 5034
2. Color Intensity	Total K/S	307	spectrophotometer
3. Deep coloration	L value	42	spectrophotometer
4. Sunshine fastness	Class	4-5	KS K ISO 105-C06
5. Friction fastness	Class	4	KS K 0650

(continued)

Evaluation Items	Units	Embodiment 1	Evaluation Method
6. Washing fastness	Class	4	KS K ISO 105-B02
7. Water fastness	Class	4-5	KS K ISO 105-E01

[0042] The second embodiment of the present invention is directed to a non-limited example of the dyeing method of the hard-to-dye fiber yarn for the industrial purpose will be described.

[Embodiment 2]

[0043] A UV ray-cured coating liquid is prepared, which is mixed with 1% by weight of phthalocyanine organic pigment (blue), 50% by weight of methyl methacrylate monomer, 15% by weight of etoxy etoxy ethylacrylate monomer, 8% by weight of hexanediol diacrylate monomer, 15% by weight of tetrahydrofurfuryl acrylate monomer, 10% by weight of polyvinyl butyral oligomer, 0.5% by weight of benzophenone as a photo initiator, 0.3% by weight of irgacure 1173 and 0.2% by weight of darocure TPO. A ultrahigh molecular weight polyethylene fiber yarn which is a hard-to-dye fiber is moved to the impregnation unit containing a coating liquid and is coated with a predetermined amount of the coating liquid and is subjected to two compressing rollers with a predetermined pressure (1MPa), thus forming a thin film coating layer. The rays from the UV ray lamp and LED of a wavelength of 260~395nm are radiated under the nitrogen environment which is an inert gas in the direction vertical to the ground, and the liquefied coating liquid is cured at a speed of 50m/min by way of the photo curing method, and it is wound using a rewinding unit into a bunch shape, thus finishing the process. A result of the physical property of the dyeing product of the ultrahigh molecular weight polyethylene which is a hard-to-dye fiber on which the coating work is finished is shown in Table 2.

[Table 2]

Evaluation Items	Units	Embodiment 2	Evaluation Method
1. Rate of change in tensile strength	%	+0.5	ASTM D 5034
2. Color Intensity	Total K/S	220	spectrophotometer
3. Deep coloration	L value	28	spectrophotometer
4. Sunshine fastness	Class	4-5	KS K ISO 105-C06
5. Friction fastness	Class	4	KS K 0650
6. Washing fastness	Class	4	KS K ISO 105-B02
7. Water fastness	Class	4-5	KS K ISO 105-E01

[Embodiment 3]

[0044] A UV ray-cured coating liquid is prepared, which is mixed with 8% by weight of phthalocyanine organic pigment (blue), 50% by weight of methyl methacrylate monomer, 5% by weight of etoxy etoxy ethylacrylate monomer, 2% by weight of hexanediol diacrylate monomer, 5% by weight of tetrahydrofurfuryl acrylate monomer, 20% by weight of polyvinyl butyral oligomer, 5% by weight of benzophenone as a photo initiator, 3% by weight of irgacure 1173 and 2% by weight of darocure TPO. A ultrahigh molecular weight polyethylene fiber yarn which is a hard-to-dye fiber is moved to the impregnation unit containing a coating liquid and is coated with a predetermined amount of the coating liquid and is subjected to two compressing rollers with a predetermined pressure (1 MPa), thus forming a thin film coating layer. The UV rays of a wavelength of 260~395nm are radiated in the direction vertical to the ground, and the liquefied coating liquid is cured by way of the photo curing method, and it is wound using a rewinding unit into a bunch shape, thus finishing the process. A result of the physical property of the thin film color coating which is a hard-to-dye fiber on which the coating work is finished is shown in Table 3.

[Table 3]

Evaluation Items	Units	Embodiment 2	Evaluation Method
1. Rate of change in tensile strength	%	+0.5	ASTM D 5034

(continued)

Evaluation Items	Units	Embodiment 2	Evaluation Method
2. Color Intensity	Total K/S	258	spectrophotometer
3. Deep coloration	L value	39	spectrophotometer
4. Sunshine fastness	Class	4-5	KS K ISO 105-C06
5. Friction fastness	Class	3-4	KS K 0650
6. Washing fastness	Class	4	KS K ISO 105-B02
7. Water fastness	Class	4-5	KS K ISO 105-E01

[Embodiment 4]

[0045] A UV ray-cured coating liquid is prepared, which is mixed 70% by weight of methyl methacrylate monomer, 8% by weight of aliphatic urethane acrylate oligomer, 12% by weight of tetrahydrofurfuryl acrylate monomer, 8% by weight of 2-hydroxyethyl acrylate monomer, 0.5% by weight of benzophenone as a photo initiator, 0.3% by weight of irgacure 1173, 0.2% by weight of darocure TPO, and 1% by weight of Red which is a high visibility fluorescent pigment. A fiber yarn of a modacryl (38%)/a cotton (32%)/a meta aramid(30%) wherein the fibers for clothes and industry are mixed and spun is moved to the impregnation unit containing a coating liquid and is coated with a predetermined amount of the coating liquid and is subjected to two compressing rollers with a predetermined pressure (1 MPa), thus forming a thin film coating layer. The rays from the UV ray lamp and LED of a wavelength of 260~395nm are radiated under the nitrogen environment which is an inert gas in the direction vertical to the ground, and the liquefied coating liquid is cured at a speed of 50m/min by way of the photo curing method, and it is wound using a rewinding unit into a bunch shape, thus finishing the process. A result of the high visibility physical property test of the modacryl-blended on which the coating work is finished is shown in Table 4.

Table 4

Test items	Hugh visibility color	Evaluation method
	Red	
Chromaticity coordinates X	0.593	ISO 20471:2031
Chromaticity coordinates Y	0.333	
Minimum Luminance Factor (%)	34.3	

Legend of reference number

100:	Creel unit	101:	Fiber yarn
200:	Body	300:	Impregnation unit
301:	Compressing roller	302:	Guide roll
400:	UV curing unit	401:	UV lamp curing unit
402:	UV LED curing unit	403:	Metal halide lamp
404:	UV LED	405:	Inert gas
500:	Winding device		

Claims

1. A high fastness dyeing method of a fiber yarn using an ultraviolet (UV) ray curing method, comprising:

preparing a UV ray-cured coating liquid mixed with a coloring, a UV ray-cured type monomer, a UV ray-cured type oligomer and a photo initiator;
impregnating a fiber yarn into the UV ray-cured coating liquid;
forming a thin film coating layer on the surface of the fiber yarn in such a way to pass it through compressing

rollers twice or more than twice with a predetermined pressure; and
curing the UV ray-cured coating liquid by radiating the rays from a UV ray lamp and a LED of a wavelength range of 260~395nm under an inert gas environment while moving the coated fiber yarn in the direction vertical to the ground.

2. The method of claim 1, wherein the UV ray-cured coating liquid is a UV ray-cured coating liquid mixed with 0.4~1% by weight of coloring, 90~98.5% by weight of UV ray-cured type monomer, 1~8% by weight of UV ray-cured type oligomer, and 0.1~1% by weight of a photo initiator, and the fiber yarn is selected from the fiber yarns wherein for a clothes purpose, one or more than one selected from the group consisting of a cotton, a wool, a silk, a hemp cloth, a rayon, an acetate, a polyethylene terephthalate (PET), a polyethyleneterephthalate (PTT), a cation dyeable PET (CDP), a nylon, an acrylic fiber, and a spandex fiber and for an industrial purpose, two or more than two selected from the group consisting of a glass fiber yarn, a polyethylene (PE) fiber yarn, a polypropylene (PP) fiber yarn, a ultrahigh molecular weight polyethylene (UHMWPE) fiber yarn, an aramid fiber yarn, a carbon fiber yarn, a polyimide (PI) fiber yarn, a polybenzoxazole (PBO) fiber yarn, and a polybenzimidazole (PBI) fiber yarn are mixed.

3. The method of claim 1, wherein the UV ray-cured coating liquid is a UV ray-cured coating liquid mixed with 0.9~10% by weight of a coloring, 30~89% by weight of a UV ray-cured type monomer, 10~40% by weight of a UV ray-cured type oligomer, and 0.1~20% by weight of a photo initiator, and the fiber yarn is one or more than one selected from a glass fiber yarn, a polyethylene (PE) fiber yarn, a polypropylene (PP) fiber yarn, a ultrahigh molecular weight polyethylene (UHMWPE) fiber yarn, an aramid fiber yarn, a carbon fiber yarn, a polyimide (PI) fiber yarn, a polybenzoxazole (PBO) fiber yarn, and a polybenzimidazole (PBI) fiber yarn are mixed.

4. The method of either claim 2 or claim 3, wherein the coloring of the UV ray-cured coating liquid is one or more than one selected among the group consisting of an inorganic pigment, an organic pigment, a dye, and an ink which have a durability against a discoloration with respect to ultraviolet rays.

5. The method of either claim 2 or claim 3, wherein the coloring is a high visibility coloring which is one or more than one selected from the group consisting of a fluorescent pigment, a fluorescent dye, and a fluorescent ink which have a durability against discoloration with respect to ultraviolet rays.

6. The method of either claim 2 or claim 3, wherein the ultraviolet ray-cured type monomer among the ultraviolet ray-cured type coating liquid is one or more than one selected from the group consisting of methyl methacrylate, isobonyl acrylate, tetrahydrofurfuryl acrylate, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxyprophyl acrylate, n-butyl acrylate, hexanediol diacrylate, etoxy etoxy ethylacrylate, and octadecyl acrylate.

7. The method of either claim 2 or claim 3, wherein the ultraviolet ray-cured type oligomer among the ultraviolet ray-cured type coating liquid is one or more than one oligomer selected from the group consisting of urethane acrylate, epoxy acrylate, unsaturated polyester acrylate, vinyl acrylate, polyvinyl butyral and polymethylmethacrylate.

8. The method of either claim 2 or claim 3, wherein the photo initiator of the ultraviolet ray curing coating liquid is one or more than one selected from the group consisting of benzophenone, Irgacure 184(1-Hydroxy-cyclohexyl-phenyl ketone), Irgacure 1173(2-Hydroxy-2-methyl-1-phenyl-1-propanone), Irgacure 907(2-methyl-1-[4-(methylthio)phenyl]-2-(4-mor-pholinyl)-1-propanone), and Darocure TPO(diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide).

9. The method of claim 1, wherein the ultraviolet ray radiation is performed by a metal halide lamp which is formed by adding, to a mercury lamp, one or more than one selected from the group consisting of Fe, Ga and Mg, and an ultraviolet ray LED.

10. The method of claim 1, wherein one or more than one selected from the group consisting of argon, nitrogen, and carbon dioxide which are inert gases is used in the UV ray radiation process to enhance a curing speed by inhibiting an oxygen inhibition operation.

11. The method of claim 1, wherein an ultraviolet ray dry process is further added before and after the ultraviolet ray radiation process.

12. The method of claim 1, wherein the process is carried out from the coating liquid impregnation of the fiber yarn to the UV ray radiation process in the direction vertical to the ground.

Figure 1

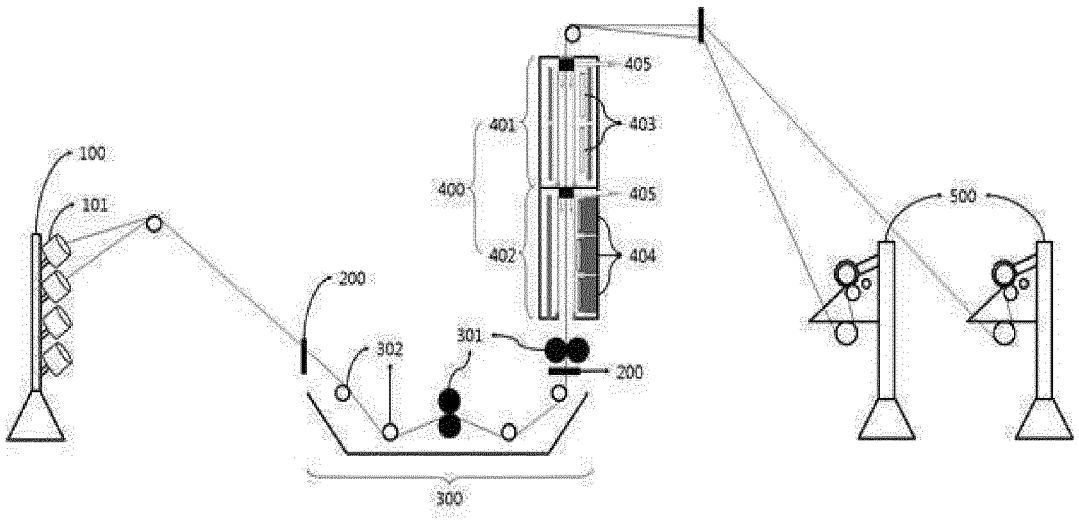


Figure 2

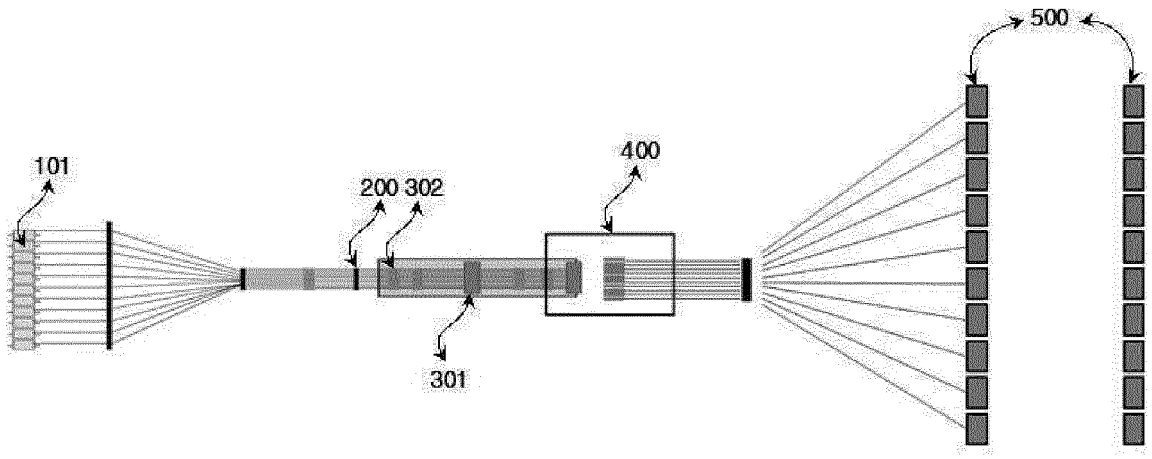
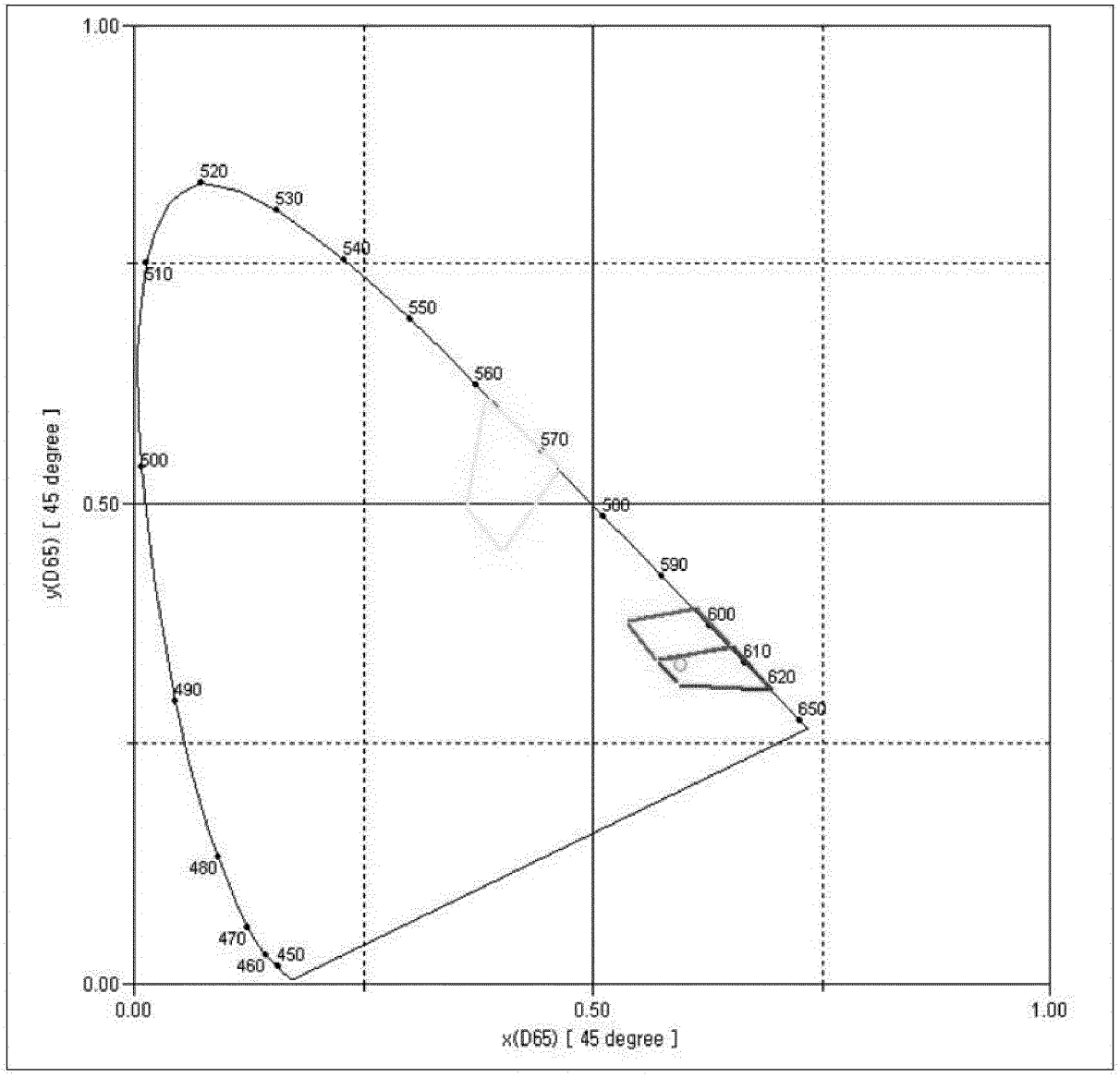


Figure 3


1.00
0.50
0.00
0.00
0.50
1.00
y(D65) [45 degree]
x(D65) [45 degree]
520
530
540
510
550
560
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500
580
590
600
610
620
650
490
480
470
460
450

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/009671

A. CLASSIFICATION OF SUBJECT MATTER

D06P 5/20(2006.01)i, D06B 1/14(2006.01)i, D06B 3/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06P 5/20; C09D 133/06; D06P 3/54; C09D 5/00; B27K 5/02; B32B 27/08; C09K 3/00; B27M 1/08; D06P 3/52; D06B 1/14; D06B 3/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: fiber filter media, coating, color, pigment, ultraviolet rays, monomer, oligomer, photo initiator, combining, irradiation, hardening

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-0157228 B1 (VENTREE CO., LTD.) 18 February 1999 See abstract; claims 1-3; and pages 2, 3.	1-12
Y	KR 10-2002-0003556 A (CHAVANOZ INDUSTRIE) 12 January 2002 See abstract; claims 1, 7, 8; and page 5, lines 1, 14-16.	1-12
A	KR 10-2006-0042288 A (AHAE CORPORATION) 12 May 2006 See abstract; claim 1; and page 3.	1-12
A	KR 10-1426834 B1 (HAN, Sang Dam) 05 August 2014 See abstract; and claims 1, 4, 6.	1-12
A	KR 10-2011-0101755 A (KYUNGPOOK NATIONAL UNIVERSITY INDUSTRY-ACADEMIC COOPERATION FOUNDATION) 16 September 2011 See abstract; and claim 1.	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 DECEMBER 2015 (23.12.2015)	**23 DECEMBER 2015 (23.12.2015)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2015/009671

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KR 10-2011-0101755 A	16/09/2011	NONE	

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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- KR 1020110101755 **[0015]**
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