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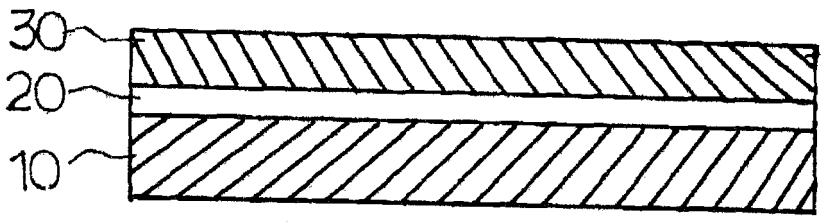
(54) BULLETPROOF FABRIC AND BODY ARMOR MANUFACTURED BY USING SAME

(57) The present invention discloses a bulletproof fabric and a body armor manufactured using the same. The bulletproof fabric includes an aramid fabric 10 including wholly aromatic polyamide multifilaments as warps and wefts, a primary water-repellent coating layer 20 formed on the aramid fabric 10, and a secondary water-repellent coating layer 30 formed on the primary water-repellent coating layer 20. The body armor of the present invention has a laminate structure of stacking up 10 to 50 sheets of the above bulletproof fabrics, preferably, further includes an aramid composite pad 40 inserted in a pocket provided at a part of the body armor. According to the present invention, water-repellent properties are excellent to noticeably improve bulletproof performance in a wet state, and specifically, when the body armor has the aramid composite pad 40 inserted therein, rear deformation of the body armor after the bulletproof performance test is considerably reduced.

FIG. 1



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Description

[Technical Field]

[0001] The present invention relates to a bulletproof fabric and body armor prepared using the same, and more particularly, to a bulletproof fabric with greatly improved bulletproofing performance in a condition of getting wet (hereinafter referred to as a "wet state") and a body armor manufactured using the same.

[Background Art]

[0002] Bulletproof garments(hereinafter referred to as a body armor) are clothes developed to protect a human body against shell splinter (broken pieces) of shells and bullets fired by enemy. The most requirement of such body armor is a bulletproof performance determining how safely the human body can be protected against bullets or shells.

[0003] In recent years, there is required development of body armor with excellent bulletproof performances in a wet state as well as in dry state.

[0004] Conventional techniques to produce body armor include dipping an aramid fabric in a water-repellent solution containing fluorine resin or the like, padding and drying the same to prepare a water-repellent aramid fabric; and then, stacking up 10 to 50 sheets of the water-repellent fabric, so as to complete the body armor with a laminate structure. Such manufactured body armor have been widely employed in the art.

[0005] However, the conventional body armor as described above involved a demerit of lowered bulletproof performance in a wet state due to poor water-repellent treatment, although the bulletproof performance in dry state was excellent.

[0006] Further, at the test of bulletproof performance, the conventional body armor were found to barely satisfy the national institute of Justice (NIJ) standards of 44 mm or less, in terms of rear deformation of body armor. Therefore, it has entailed a limitation in applying in a case that more strict standards for rear deformation are required.

[Summary of the Invention]

[Problems to be Solved by the Invention]

[0007] In order to solve the conventional problems as described above, it is an object of the present invention to provide a bulletproof fabric with improved water-proof performance in a wet state and considerably reduced rear deformation, as compared to NIJ standards for rear deformation of water-proof clothes at a bulletproof performance test, and a body armor manufactured using the same.

[Means for Solving the Problems]

[0008] In order to achieve the above object, there is provided a bulletproof fabric on which two water-repellent layers, that is, a primary water-repellent coating layer 20 and a secondary water-repellent coating layer 30 are formed sequentially by conducting water-repellent treatment of the fabric twice, thereby improving bulletproof performance in a wet state of a body armor.

[0009] In addition, the present invention includes inserting an aramid composite pad 40 into a pocket provided at a part of the body armor so as to considerably reduce rear deformation at a bulletproof performance test, wherein the aramid composite pad 40 is prepared by heat-pressing a first aramid prepreg X with a second aramid prepreg Y to form an integrated laminate structure, and wherein the first aramid prepreg X includes a high-strength aramid fabric A and a resin impregnated therein while the second aramid prepreg Y includes a high-elastic aramid fabric B and a resin impregnated therein.

[Effects of the Invention]

[0010] According to the present invention, water-repellent performance is excellent to noticeably improve bulletproof performance in a wet state and, specifically, when a body armor includes an aramid composite pad 40 inserted therein, rear deformation of the body armor after a bulletproof performance test may be considerably reduced.

[Brief Description of the Drawings]

[0011]

FIG. 1 is a cross-sectional view illustrating a bulletproof fabric according to the present invention; and

FIG. 2 is a cross-sectional view illustrating an aramid composite pad to be inserted into a pocket of a body armor.

[Description of Reference Numerals]

[0012]

10: aramid fabric, 20: primary water-repellent coating layer
30: secondary water-repellent coating layer, 40: aramid composite pad
A: high-strength aramid fabric, B: high-elastic aramid fabric
C: resin, X: first aramid prepreg
Y: second aramid prepreg

[Modes for Carrying out the Invention]

[0013] Hereinafter, the present invention will be described in more detail with reference to accompanying drawings.

[0014] A bulletproof fabric according to the present invention has a structure in which two water-repellent coating layers, that is, a primary water-repellent coating layer 20 and a secondary water-repellent coating layer 30 are sequentially formed on an aramid fabric 10, as shown in FIG. 1.

[0015] In other words, the bulletproof fabric of the present invention may include: the aramid fabric 10 including warps and wefts formed of wholly aromatic polyamide multifilaments; the primary water-repellent coating layer 20 formed on the aramid fabric 10; and the secondary water-repellent coating layer 30 formed on the primary water-repellent coating layer 20.

[0016] FIG. 1 is a cross-sectional view illustrating the bulletproof fabric according to the present invention.

[0017] The primary water-repellent coating layer 20 is a resin layer containing a water-repellent agent, preferably, fluorocarbon, and is formed using a coating solution, which is prepared by adding the water-repellent agent such as fluorocarbon to a resin solution in an amount of 2 to 35 wt.% and dispersing the same therein, according to any process of coating the aramid fabric 10 with the coating solution through dipping, spray or knife over roll coating, or the like, wherein the resin solution is prepared by dissolving resin such as acrylate in a solvent.

[0018] The water-repellent agent contained in the primary water-repellent coating layer 20 may include a variety of water-repellent agents, however, is preferably a fluorocarbon water-repellent agent because it enables water-repellent performance to be improved and retained even in a wet state.

[0019] The secondary water-repellent coating layer 30 is a polyurethane resin layer including micro-pores irregularly formed therein, and is formed by a process of coating the primary water-repellent coating layer 20 with a polyurethane resin solution through dipping, spray or knife over roll coating, wherein the polyurethane resin solution is prepared by dissolving polyurethane resin in a solvent such as dimethyl formamide.

[0020] Since the secondary water-repellent coating layer 30 includes microfine pores irregularly provided in the coating layer, which have a size smaller than a water droplet, penetration of the water droplets into the armaid fabric 10 can be prevented, therefore, water-proofing properties and water-repellent properties may be attained simultaneously even in a wet state.

[0021] A body armor according to the present invention may be configured using the bulletproof fabric of the present invention, more particularly, in a laminate form obtained by stacking up 10 to 50 sheets of the bulletproof fabrics in such a structure that two water-repellent coating layers 20 and 30 are provided in sequential order above the aramid fabric 10.

[0022] The bulletproof fabric of the present invention has such a structure that two water-repellent coating layers 20 and 30 are sequentially formed on the aramid fabric 10, thereby accomplishing noticeable improvement in water-repellent performance. Therefore, a body armor manufactured using the bulletproof fabric described above may exhibit remarkably improved bulletproof performance in a wet state.

[0023] The body armor may have a structure of including an aramid composite pad 40 inserted therein, as shown in FIG. 2, so as to preferably reduce rear deformation of the bulletproof jacket to a level smaller than 44 mm as NIJ standard, at a bulletproof performance test.

[0024] FIG. 2 is a cross-sectional view illustrating the above- described aramid composite pad 40.

[0025] The aramid composite pad 40 may have such a structure that a first aramid prepreg X is heat-pressed with a second aramid prepreg Y to form an integrated laminate, wherein the first aramid prepreg X includes a high-strength aramid fabric A and a resin C impregnated therein while the second aramid prepreg Y includes a high-elastic aramid fabric B and a resin C impregnated therein, and the high-strength aramid fabric A includes wholly aromatic polyamide multifilaments having an overall fineness of the warps and wefts in a range of 500 to 1,000 denier while the high-elastic aramid fabric B includes wholly aromatic polyamide multifilaments having an overall fineness of the warps and wefts in a range of 840 to 3,000 denier, thereby preferably further reducing rear deformation of the bulletproof jacket at a bulletproof performance test.

[0026] The aramid composite pad 40 may have a hybrid structure of the high-strength aramid fabric A including wholly aromatic polyamide multifilaments having an overall fineness of the warps and wefts in a range of 500 to 1,000 denier and the high-elastic aramid fabric B including wholly aromatic polyamide multifilaments having an overall fineness of the warps and wefts in a range of 840 to 3,000 denier.

[0027] The resin C used herein may be properly selected depending upon use of the aramid composite pad and, for example, include a polyvinyl chloride resin or a phenol resin. According to the present invention, the resin C is not particularly limited thereto.

[0028] Both of the high-strength aramid fabric A and the high-elastic aramid fabric B may be treated by a water-repellent process and, as measured by ISO 4920:1981 method, may have an initial water-repellency in a range of 90 to 100. Further, after 300 times rubbing, these fabrics preferably have the water-repellency in a range of 80 to 100.

[0029] In one embodiment of a method for formation of the aramid composite pad according to the present invention, the high-strength aramid fabric A and the high-elastic aramid fabric B may be firstly subjected to dipping in a water-repellent agent solution, followed by padding using a mangle, drying and/or heating, thereby completing the water-repellent treatment.

[0030] In this case, the water-repellent agent composition used herein may be a water-soluble solution including hydroxylated perfluoroalkylethyl acrylate copolymer.

[0031] A particular example of the water-repellent agent composition may be a water-repellent agent which includes: 1 to 5 wt.% water-soluble solution of a composition containing 5 to 35 wt.% of hydroxylated perfluoroalkylethyl acrylate copolymer, 10 to 15 wt.% of dipropylene glycol and 50 to 65 wt.% of water; and 0.1 to 1 wt. parts of silicon oil and 0.5 to 10 wt. parts of isopropylalcohol relative to 100 wt. parts of the water-soluble solution.

[0032] Next, by dipping the high-strength aramid fabric A and the high-elastic aramid fabric B treated by the above water-repellent process, respectively, in a bath containing the resin C solution, a high-strength aramid fabric A prepreg (hereinafter, referred to as a "first prepreg") and a high-elastic aramid fabric B prepreg (hereinafter, referred to as a "second prepreg") are prepared, respectively.

[0033] Following this, the first aramid prepreg X and the second aramid prepreg Y are stacked up in several sheets, followed by heat-pressing both of the laminates to form an aramid composite pad.

[0034] Alternatively, after placing a resin film between the high-strength aramid fabric A and the high-elastic aramid fabric B, both of which were treated by the water-repellent process, the above laminate may be heat-pressed to form an aramid composite pad. In this case, the resin film is molten, and partially impregnated into both of the high-strength aramid fabric A and the high-elastic aramid fabric B while partially being welded at the interface to integrate the same.

[0035] A body armor having the aramid composite pad 40 inserted in a pocket provided at a part of the body armor may exhibit excellent rear deformation of within a range of 40 mm at a bulletproof performance test according to NIJ standards.

[0036] Hereinafter, the present invention will be more particularly understood by the following examples and comparative examples.

[0037] However, these examples are proposed for more concretely explaining the present invention, while not limiting the scope of the present invention.

Example 1

[0038] A polyacrylate resin solution containing 5 wt.% of fluorocarbon was applied to one side of an aramid fabric 10 including wholly aromatic polyamide multifilaments having a fineness of the warp and weft of 840 denier/840 monofilaments, in a dipping mode, to prepare a primary water-repellent coating layer 20 having a thickness of 1.2 μm.

[0039] Next, a polyurethane solution was applied to the primary water-repellent coating layer 20 through dipping, to prepare a secondary water-repellent coating layer 30 having a thickness of 50 μm, to prepare a bulletproof fabric.

[0040] Following this, 32 sheets of the prepared bulletproof fabrics were stacked up and used for manufacturing a body armor.

[0041] Physical properties of such manufactured body armor were evaluated and results thereof are shown in Table 1.

Example 2

[0042] First, a 2.5 wt.% water-soluble solution of a composition including 30 wt.% of hydroxylated perfluoroalkylethyl acrylate copolymer, 15 wt.% of dipropyleneglycol and 55 wt.% of water was prepared. After adding 0.3 wt. part of silicon oil and 5 wt. parts of isopropylalcohol to 100 wt. parts of the above water-soluble solution, the mixture was sufficiently agitated to prepare a water-repellent agent composition. A high-strength aramid fabric A including wholly aromatic polyamide multifilaments having an overall fineness of 840 denier, each of which includes 840 wholly aromatic polyamide monofilaments having a fineness of the warp and weft of 1.0 denier, was dipped in the above water-repellent agent composition, followed by padding with a mangle and drying the same, so as to form the high-strength aramid fabric A

with water-repellent properties by water-repellent treatment.

[0043] Next, by dipping the high-strength aramid fabric A with water-repellent properties in a phenol solution, a high-strength aramid fabric A prepreg impregnated with phenol resin, that is, a first aramid prepreg X was prepared.

[0044] Meanwhile, a 2.5 wt.% water-soluble solution of a composition including 30 wt.% of hydroxylated perfluoroalkylethyl acrylate copolymer, 15 wt.% of dipropyleneglycol and 55 wt.% of water was prepared again. After adding 0.3 wt. part of silicon oil and 5 wt. parts of isopropylalcohol to 100 wt. parts of the above water-soluble solution, the mixture was sufficiently agitated to prepare a water-repellent agent composition. A high-elastic aramid fabric B including wholly aromatic polyamide multifilaments having an overall fineness of 1, 500 denier, each of which includes 1, 000 wholly aromatic polyamide monofilaments having a fineness of the warp and weft of 1.5 denier, was dipped in the above water-repellent agent composition, followed by padding with a mangle and drying the same, so as to form the high-elastic aramid fabric B with water-repellent properties.

[0045] Next, by dipping the high-elastic aramid fabric B with water-repellent properties in a phenol solution, a high-elastic aramid fabric B prepreg impregnated with phenol resin, that is, a second aramid prepreg Y was prepared.

[0046] Subsequently, three (3) sheets of the first aramid prepreg X and three (3) sheets of the second aramid prepreg Y were laminated together, followed by heat-pressing the same to form an aramid composite pad.

[0047] Following this, after forming a pocket at a part of the body armor manufactured according to the same procedures as described in Example 1, a sheet of the aramid composite pad formed as described above was inserted into the pocket.

[0048] Physical properties of the manufactured body armor were evaluated and results thereof are shown in Table 1.

Comparative Example 1

[0049] First, a 2.5 wt.% water-soluble solution of a composition including 30 wt.% of hydroxylated perfluoroalkylethyl acrylate copolymer, 15 wt.% of dipropyleneglycol and 55 wt.% of water was prepared. After adding 0.3 wt. part of silicon oil and 5 wt. parts of isopropylalcohol to 100 wt. parts of the above water-soluble solution, the mixture was sufficiently agitated to prepare a water-repellent agent composition. Then, a wholly aromatic polyamide fabric refined using a surfactant was dipped in the above water-repellent agent composition, to impregnate the water-repellent agent composition into the wholly aromatic fabric.

[0050] The wholly aromatic polyamide fabric used in this example was a fabric woven in a plain form with each of warp and weft densities of 10 threads/cm by using wholly aromatic polyamide multifilaments as the warps and wefts, each of which includes 1,000 wholly aromatic polyamide monofilaments having a fineness of 1.0.

[0051] Following this, a part of the water-repellent agent composition impregnated in the wholly aromatic polyamide fabric was removed, in particular, at a pick-up rate of 60%, using a mangle. Then, the treated fabric was dried in a tenter at 150°C for 1 minute, thereby preparing a bulletproof fabric.

[0052] Subsequently, 40 sheets of the prepared bulletproof fabrics were stacked up to manufacture a body armor.

[0053] Physical properties of the manufactured body armor were evaluated and results thereof are shown in Table 1.

[TABLE 1]

Physical properties of body armor			
Items	Example 1	Example 2	Comparative Example 1
Bulletproof performance in a wet state (satisfaction of 3AV0 standards according to NIJ)	Satisfied	Satisfied	Not satisfied
Rear deformation of body armor at a bulletproof performance test	40	20	44

[0054] With regard to evaluation of the physical properties stated in the above Table 1, bulletproof performance was measured according to the following procedure.

Measurement of bulletproof performance

[0055] After dipping each of the prepared armaid composites in water for 30 minutes, bulletproof performance was tested using a 44 magnum (44 mag) with a 3A grade standard according to National Institute of Justice (NIJ), immediately after taking out the aramid composite. Meanwhile, on the basis of 436 m/sec, which is a bullet speed of 44 mag, V0 was measured within a range of acceptable standards to evaluate the bulletproof performance.

[Industrial Applicability]

[0056] According to the present invention, water-repellent performance is excellent to noticeably improve bulletproof performance in a wet state. Especially, in a case that the aramid composite pad 40 is inserted in a pocket provided in a body armor, rear deformation of the body armor after execution of a bulletproof performance test is considerably reduced, therefore, the present invention is effectively useable in manufacturing body armor.

Claims

1. A bulletproof fabric, comprising: an aramid fabric 10 including wholly aromatic polyamide multifilaments as warps and wefts; a primary water-repellent coating layer 20 formed on the aramid fabric 10; and a secondary water-repellent coating layer 30 formed on the primary water-repellent coating layer 20.

2. The bulletproof fabric according to claim 1, wherein the primary water-repellent coating layer 20 is a resin layer containing fluorocarbon.

3. The bulletproof fabric according to claim 1, wherein the secondary water-repellent coating layer 30 is a polyurethane resin layer including micro-pores formed therein.

4. A body armor manufactured by laminating 10 to 50 sheets of bulletproof fabric, wherein the fabric includes: an aramid fabric 10 including wholly aromatic polyamide multifilaments as warps and wefts; a primary water-repellent coating layer 20 formed on the aramid fabric 10; and a secondary water-repellent coating layer 30 formed on the primary water-repellent coating layer 20.

5. The body armor according to claim 4, wherein bulletproof performance in a wet state satisfies VO standards of the National Institute of Justice (NIJ) 3A.

6. The body armor according to claim 4, wherein an aramid composite pad 40 is inserted in a pocket provided at a part of the body armor.

7. The body armor according to claim 6, wherein the aramid composite paid 40 has a structure in which a first aramid prepreg X is heat-pressed with a second aramid prepreg Y to form an integrated laminate, wherein the first aramid prepreg X includes a high-strength aramid fabric A and a resin C impregnated therein while the second aramid prepreg Y includes a high-elastic aramid fabric B and a resin C impregnated therein, and the high-strength aramid fabric A includes wholly aromatic polyamide multifilaments having an overall fineness of the warps and wefts in a range of 500 to 1,000 denier while the high-elastic aramid fabric B includes wholly aromatic polyamide multifilaments having an overall fineness of the warps and wefts in a range of 840 to 3,000 denier.

8. The body armor according to claim 6, wherein rear deformation of the body armor at a bulletproof performance test according to NIJ standards is within 40 mm.

FIG. 1

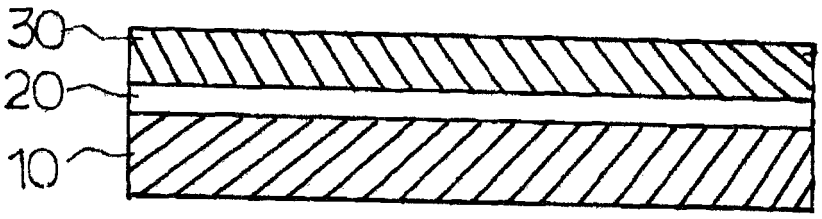
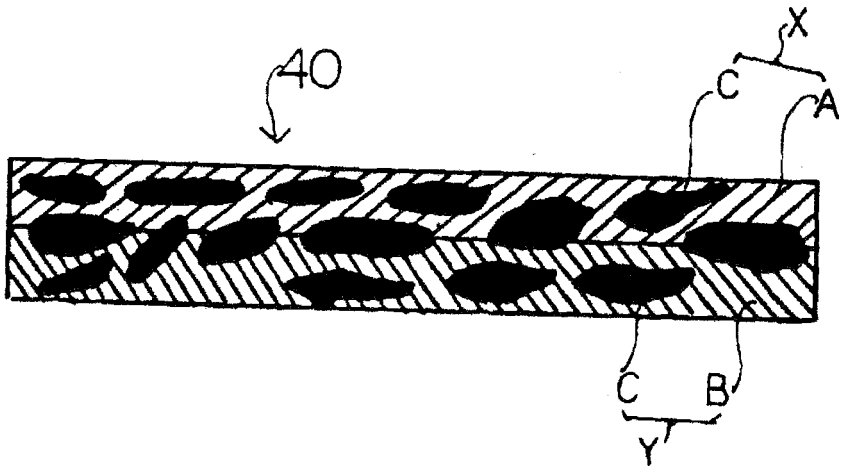


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2011/010129

A. CLASSIFICATION OF SUBJECT MATTER

D06M 15/00(2006.01)i, D03D 15/00(2006.01)i, D06M 11/73(2006.01)i, D06M 15/564(2006.01)i, F41H 1/02(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)

D06M 15/00; D06N 3/14; F14H 1/02; D03D 15/00; D06C 7/02; D03D 1/00; A42B 3/06; A42B 3/00; B32B 27/02

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: aramid, bulletproof, water repellent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2009-0076225 A (KOLON INDUSTRIES, INC.) 13 July 2009 See claims 7 and 8.	1-8
Y	KR 10-0829459 B1 (KOLONGLOTECH. INC) 15 May 2008 See abstract and [0007].	1-8
Y	KR 20-0392560 Y1 (AGENCY FOR DEFENSE DEVELOPMENT) 19 August 2005 See claims 1 to 4, and page 2, lines 35-36.	6-8
E	KR 10-2012-0002668 A (KOLON INDUSTRIES, INC.) 09 January 2012 See claims 1 to 8.	1-8

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
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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
25 SEPTEMBER 2012 (25.09.2012)	**26 SEPTEMBER 2012 (26.09.2012)**
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/KR2011/010129

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2009-0076225 A	13.07.2009	NONE	
KR 10-0829459 B1	15.05.2008	NONE	
KR 20-0392560 Y1	19.08.2005	NONE	
KR 10-2012-0002668 A	09.01.2012	NONE	

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