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(54) Title: A DIPPING MATERIAL FOR CORD FABRICS AND A PRODUCTION METHOD THEREOF

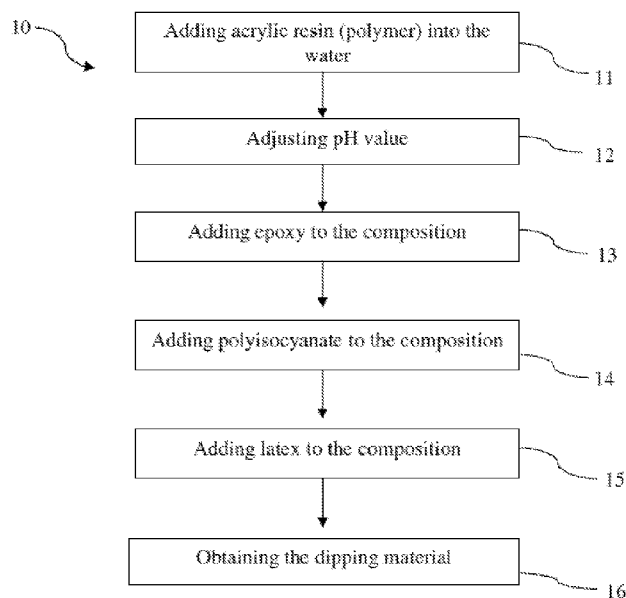


Figure 1

(57) Abstract: The present invention relates to a dipping solution for cord fabrics and a production method thereof comprising the steps of adding acrylic resin (polymer) into water (11), adjusting pH value (12), adding epoxy to the composition (13), adding polyisocyanate to the composition (14), adding latex to the composition (15), obtaining the dipping material (16); enabling the synthetic fiber and the rubber used in cord fabric reinforced rubber materials production to be attached to each other by providing an interface between two said materials; not as hazardous as RFL for human health and also being environmental friendly.





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5        **A DIPPING MATERIAL FOR CORD FABRICS AND A PRODUCTION  
METHOD THEREOF**

**Field of the Invention**

10        The present invention relates to a dipping solution for cord fabrics which enables  
the synthetic fiber and the rubber to be attached to each other by providing a  
phase between the said two structures, and which is environmental friendly, and a  
production method thereof.

**Background of the Invention**

15        Since the chemical structures of synthetic fibers used in the cord fabric production  
and the rubber are considerably different from each other, the said materials are  
incompatible with each other in terms of their chemical and physical structures.  
The synthetic fibers have high strength and low elongation whereas the rubbers  
contrarily are polymeric materials which have high elongation and low strength.  
20        The polar groups (amide, hydroxyl and carbonyl groups) present in the structure  
of the synthetic fibers are incompatible with the non-polar structures of the  
rubber. This incompatibility is eliminated with water-based Resorcinol-  
Formaldehyde-Latex (RFL) adhesive solutions which form a phase between the  
cord and the rubber and enable the rubber and the fiber to be attached to each  
25        other.

Main function of RFL is to serve as adhesive attaching two incompatible  
structures by forming phase between fiber and rubber. RF functional group  
within RFL is attached to the polar groups of fiber, Latex (L) group is attached to  
the fiber with vulcanization and the rubber-fiber composite structure is formed.

30        The vehicle tire application amongst the most significant product examples  
wherein the said composite structure is used. The water based RFL adhesives are  
applied on cord fabric during “dipping” process which is the final step of cord  
fabric production. The strength of the bonds formed between the rubber and the  
cord is examined with adhesion tests. Adhesion is very important parameter in

5 high tenacity cord reinforced rubber products. Because cord-rubber adhesion is a critical factor which affects the tire performance.

Formaldehyde-free dipping solutions for rubber materials reinforced with cord have been reported in various studies.

United States Patent document no US20120041113, an application known in the state of the art, discloses preparing a composition comprising epoxy, blocked  
10 isocyanate, epoxy curing agent and vinyl pyridine latex.

International Patent document no WO9600749, another application known in the state of the art, discloses applying dipping solutions formulated with three functional epoxy resins, styrene-butadiene-vinyl pyridine and styrene-butadiene-  
15 acrylonitrile-acrylic acid latex to the polyethylene terephthalate (PET) material and adhesion strength with rubber.

United States Patent document no US5118545, another application known in the state of the art, discloses the synthesis of an aramide with multiple double bonds. It is stated that the synthesized resin is applied on the aramide based cord fabric  
20 and the double bonds in aramide resin are vulcanized with the double bonds in rubber, and the amide groups provide physical adhesion to the aramide fiber.

United States Patent document no US4472463, another application known in the state of the art, discloses dipping non-adhesive activated PET fibers with two step process dipping. The first step dipping comprises aromatic glycidyl ester epoxy  
25 and blocked isocyanate, while the second step dipping comprises two various latex. The first latex is styrene-butadiene-vinyl pyridine copolymer, and the other one is acrylic acid-methyl methacrylate-styrene copolymer. It is stated that higher adhesion values are obtained in H-adhesion tests compared to RFL dipping solution.

30 United States Patent document no US20040249053, another application in the state of the art wherein an environmental friendly dipping material is disclosed. In that application, the maleinized polybutadiene is reacted with polyethylene glycol

5 and become water soluble. The PET cords modified with epoxy are first dipped with this resin and then with styrene-butadiene-vinyl pyridine latex. However the stripping-adhesion strength of the rubber with PET cords dipped with this resin is lower than the fabrics with RFL.

RFL adhesive formulation has been used as adhesive material in all synthetic fiber  
10 reinforced materials for over half century because of its stable structural characteristics and low cost. However, both resorcinol and formaldehyde are the hazardous chemicals which create a great risk for human and environmental health. Therefore, their use has to be limited. Regarding this subject, feedbacks have come from international organizations and customers. It is known that the  
15 resorcinol causes itching and rash when it contacts the skin, irritates the eye and shows toxic properties in liver and cardiovascular systems.

Formaldehyde is riskier than resorcinol for human health and safety. In 2004, formaldehyde is classified as group 2A chemical (possible carcinogen in humans) by a group of scientists in International Agency for research on Cancer (IARC) of  
20 World Health Organization, and as group 1 (carcinogen for humans) for a group of scientists. In 2009, formaldehyde is included in list of chemicals causing leukemia by IARC. According to these, formaldehyde is suggested to be gene mutagen. Even low amounts of formaldehyde (1ppm) cause eye, nose and throat irritation.

25 Although formaldehyde resins have advantage in terms of cost, both producers and consumers search for alternatives because of the reasons expressed above.

### **Summary of the Invention**

The objective of the present invention is to provide a dipping material for cord fabrics which comprises more environment friendly chemicals than formaldehyde  
30 and resorcinol.

5 Another objective of the present invention is to provide production method for dipping solution of cord fabrics which takes shorter time than the method used in the state of the art.

A further objective of the present invention is to provide a dipping solution for  
10 cord fabrics which is in white color and thus makes it possible to produce colorful cords.

### **Detailed Description of the Invention**

The dipping material for cord fabrics and a production method thereof developed  
15 to fulfill the objective of the present invention is illustrated in the accompanying figure, in which;

Figure 1 is the view of the flowchart of the method.

Figure 2 is the view of the table wherein the strip adhesion values of 8 different  
20 inventive mixtures, the composition ratios of which are different, and Resorcinol-Formaldehyde-Latex (RFL) adhesive solutions are compared.

The production method for the dipping solution for cord fabrics (10) comprises the steps of:

- 25
- adding acrylic resin (polymer) into water (11),
  - adjusting pH value (12),
  - adding epoxy to the composition (13),
  - adding polyisocyanate to the composition (14),
  - adding latex to the composition (15),

30

  - obtaining the dipping material (16).

In the inventive production method for dipping material for cord fabrics (10), first functional acrylic resin (polymer) material comprising carboxylic acid is added into the water (1). The functionality of the resin comprising carboxylic acid, at least one of the monomers such as acrylic acid, methacrylic acid, itaconic acid,

5 crotonic acid, cinnamic acid, maleic acid is used. In the preferred embodiment of the invention, the amount of carboxylic acid within acrylic polymer is between 1-50% by mole. In one embodiment of the invention this rate is kept between 1-30%.

Then, pH value of this composition comprising water and acrylic polymer is  
10 adjusted (2). In the preferred embodiment of the invention, ammonium hydroxide is added to the composition until the pH value of the composition is 10-11.

After pH is adjusted to the desired level, epoxy is added into the composition (3). In the preferred embodiment of the invention, the epoxy which is used is water soluble or water based dispersion. At least one of the materials such as glycidyl  
15 based glycerol and sorbitol epoxy, phenol novalac epoxy, cresol novalac epoxy is used as epoxy. However their use is not limited to these. Any epoxy which is water soluble or can be prepared in dispersion can be used in this invention.

Then polyisocyanate is added to the composition (4). In the preferred embodiment of the invention, polyurethane prepolymer comprising water based blocked  
20 polyisocyanate or water based blocked isocyanate groups is used. At least one of tetramethylene diisocyanate, hexamethylene diisocyanate (1,6-diisocyanatohexane), octamethylene diisocyanate, decamethylene diisocyanate, dodecamethylene diisocyanate, aromatic diisocyanates 2,4- or 2,6-tolylene diisocyanate, tetramethylxyliene diisocyanate, p-xylene diisocyanate, 2,4'- or 4-  
25 4'-diisocyanatediphenylmethane, 1,3- or 1,4-phenylene diisocyanate is used as polyisocyanate by itself or as it is added to the polymers. In the preferred embodiment of the invention, the molecular weight of the polyurethane prepolymer comprising water based blocked isocyanate groups is in the range of 1000-10000 g/mol, in one embodiment of the invention this value is between  
30 1500-3000 g/mol.

5 After adding polyisocyanate, latex is added (5). Within latex, there are butadiene-styrene- vinyl-pyridine monomers. In the preferred embodiment of the invention, the solid amount inside the latex is between 35-45 % by weight.

The dipping solution is obtained by adding all materials mentioned in the previous steps into the water at room temperature and stirring it (6).

10 Different acrylic polymers, epoxies and polyisocyanates were used in different ratios and 8 compositions were prepared. The related table is given in Figure 2, and strip adhesion values of these compositions are indexed according to strip adhesion value of Resorcinol-Formaldehyde-Latex (RFL) adhesive solution.

In the preferred embodiment of the invention, acrylic resin ratio of 1-7 % by  
15 weight, epoxy in ratio of 0.6-2.5 %, and polyisocyanate in ratio of 6-21 % are used.

The dipping solution prepared with the inventive production method for cord fabrics (10) can be used in dipping cords such as nylon 6.6, nylon 6, polyethylene terephthalate, polyethylene naphthalate, rayon, aramide, and it is not limited to  
20 these. After the said cords are prepared in certain constructions (ply number and twist), it is dipped with the inventive dipping material and dried at between 100-150 °C and then cured at between 200-240 °C. The dipped cords are pressed into the non-vulcanized (green) rubber composition in molds. The said composite material is generally cured at 170 °C under pressure for about 20 minutes, and the  
25 final cord is obtained.

In an exemplary embodiment of the composition, the amount of solid is determined as 15%, and pH is adjusted to 10-11 range by adding ammonium hydroxide (12). The inventive dipping solution method was used in dipping 2 layered, 1400 dtex value, 396x396 twisted nylon 6.6 cords. The dipped cords were  
30 first dried for 60 seconds at 130°C, then cured for 60 seconds at 235 and 230 °C, respectively.

5 Acrodur 950 and 3515 were used as acrylic functional polymer. The said water based polymers comprise carboxylic acid, polybasic alcohol groups with 50% solid.

EX313 and EX614B were used as epoxy. EX313 is a glycerol based glycidyl epoxy, and EX614B is sorbitol based glycidyl epoxy resin. The said resins are  
10 100% soluble in water.

Grilbond IL-6 or BN-27 was used as blocked polyisocyanate or polyurethane. Grilbond IL-6 is water based caprolactam blocked 1,4-phenylene diisocyanate with 60% solid. BN-27 is a water based polyurethane prepolymer comprising blocked isocyanates with 30% solid.

15 The solid amount of styrene-butadiene-vinyl-pyridine latex is 41%, and pH value is 10.5

It is possible to obtain a dipping solution for rubber composites by using environmental friendly chemicals with the inventive dipping solution production method (10). Furthermore, the said method provides opportunities such as cost  
20 and time saving. Since the final product is white it is aesthetically appealing and also enables cord fabrics to be produced in various colors with pigment additives.

Within the framework of these basic concepts, it is possible to develop various embodiments of the inventive dipping material for cord fabrics and a production method thereof. The invention cannot be limited to the examples described herein  
25 and it is essentially as defined in the claims.

5

## CLAIMS

- 10  
15
1. A production method of dipping solution for cord fabrics (10), which enables the synthetic fiber and the rubber to be attached to each other by providing an interface in between the said two structures and is also environmental friendly, **characterized by** the steps of
- adding acrylic resin (polymer) into water (11),
  - adjusting pH value (12),
  - adding epoxy to the composition (13),
  - adding polyisocyanate to the composition (14),
  - 15 -adding latex to the composition (15),
  - obtaining the dipping material (16).
- 20
2. A production method for dipping solution for cord fabrics (10) according to claim 1, **characterized by** the step of adding acrylic resin (polymer) in to the water (11) wherein functional acrylic resin comprising carboxylic acid is used.
- 25
3. A production method for dipping solution for cord fabrics (10) according to any one of the preceding claims, **characterized by** the step of adding acrylic resin (polymer) into the water (11) wherein at least one of the monomers such as acrylic acid, methacrylic acid, itaconic acid, crotonic acid, cinnamic acid, maleic acid is used as carboxylic acid.
- 30
4. A production method for dipping solution for cord fabrics (10) according to any one of the preceding claims, **characterized by** the step of adding acrylic resin (polymer) into the water (11) wherein the carboxylic acid amount inside the acrylic polymer is in the range of 1-50% by mol.

- 5           **5.** A production method for dipping solution for cord fabrics (10) according to  
any one of the preceding claims, **characterized by** the step of adjusting pH  
level (12) wherein ammonium hydroxide is added until pH value is 10-11.
- 10           **6.** A production method for dipping solution for cord fabrics (10) according to  
any one of the preceding claims, **characterized by** the step of adding epoxy  
into the composition (13) wherein epoxy material is used as water soluble or  
water based dispersion.
- 15           **7.** A production method for dipping solution for cord fabrics (10) according to  
any one of the preceding claims, **characterized by** the step of adding epoxy  
to the composition (13) wherein at least one of epoxies such as glycidyl  
based glycerol and sorbitol epoxy, phenol novalac epoxy, cresol novalac  
epoxy or epoxy water dispersion of which is can be prepared is used the  
epoxy.
- 20           **8.** A production method for dipping solution for cord fabrics (10) according to  
any one of the preceding claims, **characterized by** the step of adding  
polyisocyanate into the composition (14) wherein polyurethane polymer  
comprising water based blocked polyisocyanate or water based blocked  
25           isocyanate groups is used.
- 30           **9.** A production method for dipping solution for cord fabrics (10) according to  
any one of the preceding claims, **characterized by** the step of adding  
polyisocyanate into the composition (14) wherein at least one of  
tetramethylene diisocyanate, hexamethylene diisocyanate (1,6-  
diisocyanatohexane), octamethylene diisocyanate, decamethylene  
diisocyanate, dodecamethylene diisocyanate, aromatic diisocyanates 2,4- or  
2,6-tolylene diisocyanate, tetramethylxyliene diisocyanate, p-xylene  
diisocyanate, 2,4'- or 4-4'-diisocyanatediphenylmethane, 1,3- or 1,4-

- 5 phenylene diisocyanate is used as polyisocyanate by itself or as it is added to the polymers.
- 10 **10.** A production method for dipping solution for cord fabrics (10) according to any one of the preceding claims, **characterized by** the step of adding latex into the composition (15) wherein latex comprising butadiene, styrene, vinyl pyridine monomers is used.
- 15 **11.** A production method for dipping solution for cord fabrics (10) according to any one of the preceding claims, **characterized by** the step of obtaining dipping solution (16) wherein the final product is obtained by adding the materials used in the previous steps into the water and stirring at room temperature.
- 20 **12.** A production method for dipping solution for cord fabrics (10) according to any one of the preceding claims, **characterized by** the step of obtaining the dipping solution (16) wherein a dipping solution is acquired which comprises acrylic resin ratio of 1-7 % by weight, epoxy in ratio of 0.6-2.5 %, and polyisocyanate in ratio of 6-21 %.
- 25 **13.** A dipping solution for cord fabrics which is obtained with a method according to any one of the preceding claims.
- 30 **14.** Nylon 6.6, nylon 6, polyethylene terephthalate, polyethylene naphthalate, rayon or aramide cord which is dipped with a dipping solution according to claim 13.

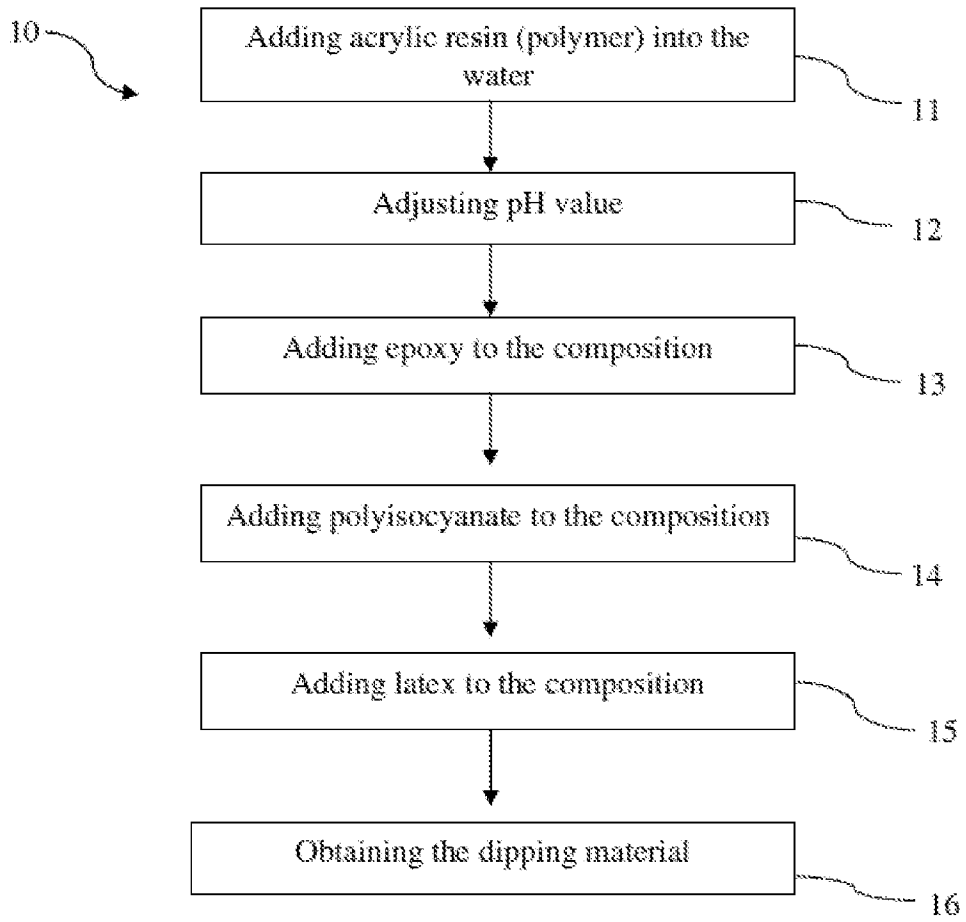


Figure 1

| Examples of Functional compositions acrylic polymer | Epoxy | Polyisocyanate | Acrylic resin % | Epoxy% | Polyisocyanate% | Latex% | Strip adhesion (index) |
|---|-------|----------------|-----------------|--------|-----------------|--------|------------------------|
| 1 Acrodur 950                                       | EX313 | IL6            | 3.7%            | 2.52   | 7.40            | 86.30  | 102                    |
| 2 Acrodur 950                                       | EX313 | BN27           | 1.38            | 0.92   | 20.39           | 77.32  | 88                     |
| 3 Acrodur 950                                       | EX614 | IL6            | 4.07            | 1.99   | 7.96            | 85.96  | 66                     |
| 4 Acrodur 950                                       | EX614 | BN27           | 1.41            | 0.69   | 20.94           | 76.96  | 90                     |
| 5 Acrodur 3515                                      | EX313 | IL6            | 6.23            | 2.05   | 6.03            | 85.69  | 91                     |
| 6 Acrodur 3515                                      | EX313 | BN27           | 2.57            | 0.85   | 18.83           | 77.75  | 84                     |
| 7 Acrodur 3515                                      | EX614 | IL6            | 6.62            | 1.60   | 6.41            | 85.38  | 93                     |
| 8 Acrodur 3515                                      | EX614 | BN27           | 2.64            | 0.64   | 19.30           | 77.43  | 89                     |
| Control   | RFL   |                |                 |        |                 |        | 100                    |

Figure 1

# INTERNATIONAL SEARCH REPORT

|   |
|---|
| International application No<br>PCT/IB2013/060693 |
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|   |  |                       |
|---|--|-----------------------|
| <b>A. CLASSIFICATION OF SUBJECT MATTER</b><br>INV. C08J5/06      D06M15/263      D06M15/55      D06M15/693      C09J109/08<br>ADD.                                      |  |                       |
| According to International Patent Classification (IPC) or to both national classification and IPC   |  |                       |
| <b>B. FIELDS SEARCHED</b><br>Minimum documentation searched (classification system followed by classification symbols)<br>C08J D06M C09J                                |  |                       |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched   |  |                       |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br>EPO-Internal, WPI Data                  |  |                       |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>   |  |                       |
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
| X   | JP 2011 069020 A (BRIDGESTONE CORP)<br>7 April 2011 (2011-04-07)<br>abstract<br>-----  | 1-14                  |
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| -----<br>-/--   |  |                       |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.  | <input checked="" type="checkbox"/> 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  | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  |                       |
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| Name and mailing address of the ISA/<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016    | Authorized officer<br><br>Fiocco, Marco  |                       |

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2013/060693

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
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Information on patent family members

|   |
|---|
| International application No<br>PCT/IB2013/060693 |
|---|

| Patent document<br>cited in search report |   | Publication<br>date | Patent family<br>member(s)     | Publication<br>date      |
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