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(54) Title: FOAM FOR FOOTWEAR MIDSOLE AND THE LIKE

High Performance Foam Formulation			Conventional EVA Foam	
Raw Material	PHR*	Range (PHR)	Raw Material	PHR
EVA 18%	70	65-75	EVA 18%	100
Engage 8200	20	15-25	/	/
Infuse 9107	10	05-20	/	/
ZnO	1.5	1.25-1.75	ZnO	1.5
STA	0.5	0.3-0.7	STA	0.5
Filler	10	5-15	Filler	10
TiO ₂	1.5	1.25-1.75	TiO ₂	1.5
Other pigment	/	/	Other pigment	/
Blowing agent	2.5	2.25-2.75	Blowing agent	2.5
DCP (Crosslinker)	0.5	0.4-0.7	DCP (Crosslinker)	0.5

*Parts per hundred resin

Figure 1

(57) Abstract: [0030] Embodiments herein provide high performance foam formulations and processing methods that address issues with traditional ethylene vinyl acetate (EVA) foams. In various embodiments, when used in midsoles, the high performance foam formulations may provide superior impact energy absorption per given load during compression, improved energy recovery during expansion, and reduced compression set over repeated impact cycles. In various embodiments, the high performance foam formulations may include a mixture of no more than about 75 PHR EVA foam and at least 15 PHR polyolefin foam.

Foam for Footwear Midsole and the Like

Cross Reference to Related Applications

[0001] The present application claims priority to U.S. Provisional Patent Application No. 61/662,826, filed June 21, 2012, entitled "Foam for Footwear Midsole and the Like," the entire disclosure of which is hereby incorporated by reference in its entirety.

Technical Field

[0002] Embodiments herein relate to the field of foams for footwear midsoles and other such applications.

Background

[0003] Ethylene vinyl acetate (EVA) is commonly used as a polymer in the foam chemistry of athletic footwear cushioned midsoles. EVA is light, relatively inexpensive and has good cushioning properties when new. However, the cushioning properties tend to diminish quickly with use.

[0004] Some footwear manufacturers blend more durable polymers (e.g., polyolefin elastomer) with EVA or replace EVA altogether in order to reduce compression set and enhance resiliency and durability. But, certain elastomeric foams can be expensive and the ranges of performance properties are somewhat limited. Polyolefins have excellent chemical resistance, which renders them difficult to bond with solvent cements, and the surfaces of polyolefin foams have a greater tendency to become oily to the touch. Some manufacturers address this by limiting the amount of polyolefin blended throughout the midsole (typically less than 15%). Other manufacturers apply the polyolefinic foam in a localized fashion, such as under the center of the heel, and then use standard foam throughout the rest of the midsole.

Brief Description of the Drawings

[0005] Embodiments will be readily understood by the following detailed description in conjunction with the accompanying drawings and the appended

claims. Embodiments are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings.

[0006] **Figure 1** is a table illustrating the composition of one specific, non-limiting example of a high performance foam as compared to conventional EVA foam, in accordance with various embodiments; and

[0007] **Figure 2** is a table illustrating several properties of the high performance foam of **Figure 1**, as compared to conventional EVA foam, in accordance with various embodiments.

Detailed Description of Disclosed Embodiments

[0008] In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which are shown by way of illustration embodiments that may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope. Therefore, the following detailed description is not to be taken in a limiting sense, and the scope of embodiments is defined by the appended claims and their equivalents.

[0009] Various operations may be described as multiple discrete operations in turn, in a manner that may be helpful in understanding embodiments; however, the order of description should not be construed to imply that these operations are order dependent.

[0010] The description may use perspective-based descriptions such as up/down, back/front, and top/bottom. Such descriptions are merely used to facilitate the discussion and are not intended to restrict the application of disclosed embodiments.

[0011] The terms “coupled” and “connected,” along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. Rather, in particular embodiments, “connected” may be used to indicate that two or more elements are in direct physical contact with each other. “Coupled” may mean that two or more elements are in direct physical contact. However, “coupled” may also mean that two or more elements are not in direct contact with each other, but yet still cooperate or interact with each other.

[0012] For the purposes of the description, a phrase in the form “A/B” or in the form “A and/or B” means (A), (B), or (A and B). For the purposes of the description,

a phrase in the form "at least one of A, B, and C" means (A), (B), (C), (A and B), (A and C), (B and C), or (A, B and C). For the purposes of the description, a phrase in the form "(A)B" means (B) or (AB) that is, A is an optional element.

[0013] The description may use the terms "embodiment" or "embodiments," which may each refer to one or more of the same or different embodiments. Furthermore, the terms "comprising," "including," "having," and the like, as used with respect to embodiments, are synonymous, and are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.).

[0014] With respect to the use of any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0015] Embodiments herein provide high performance foam formulations and processing methods that address issues with traditional EVA foams. In various embodiments, when used in midsoles, the high performance foam formulations may provide superior impact energy absorption per given load during compression, improved energy recovery during expansion, and reduced compression set over repeated impact cycles.

[0016] In various embodiments, the high performance foam formulations may utilize block copolymers to achieve stability. Certain embodiments may use greater concentrations of polyolefins as compared to traditional foams, without degrading the ability to bond adjoining footwear parts. For example, in various embodiments using such high performance foams, an entire midsole may be formed using a greater percentage of polyolefin compared to known foams, and yet, in embodiments, may remain easy to bond, provide an oil-free feel, and/or deliver superior cushioning performance and durability. In various embodiments, one or more polyolefin elastomers and/or olefin block copolymers may be combined with ethylene vinyl acetate (EVA) to create a foam having greater resilience, greater tensile strength, reduced shrinkage, reduced compression set, and/or improved bonding, as compared to EVA alone and/or other EVA/polyolefin foams.

[0017] In various embodiments, suitable olefinic polymers for the production of the high performance foam formulations disclosed herein may include linear high density polyethylene (HDPE), linear low density polyethylene (LLDPE; e.g., DOWLEX™ brand LLDPE, made by The Dow Chemical Company, Midland, MI), and ultra low linear density polyethylene (ULDPE; e.g., ATTANE™ brand ULDPE, manufactured by The Dow Chemical Company), etc., homogeneously branched, linear ethylene/alpha-olefin copolymers (e.g., TAFMER™ brand copolymer, manufactured by Mitsui PetroChemicals Company Limited, and EXACT™ brand copolymer, manufactured by Exxon Chemical Company), homogeneously branched, substantially linear ethylene/alpha-olefin polymers (e.g., AFFINITY™, ENGAGE™, and INFUSE™ brand polymers, manufactured by The Dow Chemical Company), and high pressure, free radical polymerized ethylene copolymers, such as EAA (e.g., PRIMACOR™ polymer, manufactured by The Dow Chemical Company) and EVA (e.g., ESCORENE™ polymer, manufactured by Exxon Chemical Company, and ELVAX™ polymer, manufactured by E. I. du Pont de Nemours & Co.).

[0018] In particular embodiments, the olefinic polymers may include homogeneously branched linear and substantially linear ethylene copolymers with a density (measured in accordance with ASTM D-792) from about 0.85 to about 0.92 g/cm³, especially from about 0.85 to about 0.90 g/cm³ and a melt index (measured in accordance with ASTM D-1238 (190/2.16)) from about 0.1 to about 10 g/10 minutes. In various embodiments, the EVA may contain from about 0.5 to about 50 wt% derived from vinyl acetate, and may include one or more EVA polymers having a melt index (ASTM D-1238 (190/2.16)) from about 0.5 to about 10 g/10 minutes. Although the disclosed high performance foams are typically described as including EVA, one of skill in the art will appreciate that in some embodiments, EAA (containing from about 0.5 to about 25 wt% derived from acrylic acid) and similar ethylenically unsaturated carboxylic acid containing polymers also may be substituted.

[0019] As described herein, various embodiments of the disclosed foams may include polyolefin elastomers and/or olefin block copolymers. As used herein, the term "polyolefin elastomer" may refer to a copolymer of ethylene and another alpha-olefin such as butene or octene. In various embodiments, a metallocene catalyst may be used to selectively polymerize ethylene and comonomer sequences, and increasing the comonomer content may produce polymers with higher elasticity as

the comonomer incorporation disrupts the polyethylene crystallinity. In various embodiments, the molecular weight of the copolymer may help determine the processing characteristics and end-use performance properties of the polyolefin elastomer, with higher molecular weights providing enhanced polymer toughness.

[0020] In various embodiments, polyolefin copolymers may be produced using refined metallocene catalysts often referred to as single-site or constrained geometry catalysts. These catalysts may have a constrained transition metal (generally a Group 4B metal such as Ti, Zr, or Hf) sandwiched between one or more cyclopentadienyl ring structures to form a sterically hindered polymerization site. In various embodiments, this catalyst may provide a single polymerization site instead of the multiple sites of conventional catalysts, and may provide the capability to tailor the molecular architecture of ethylene copolymers.

[0021] As used herein, the term “olefin block copolymer” may refer to a polymer having chains with alternating blocks of “hard” (highly rigid) and “soft” (highly elastomeric) segments that are created and assembled via a shuttling process. In various embodiments, because the alternating block types provide highly differentiated material properties along the chain, the traditional relationship of flexibility and heat resistance in the polymer may be disrupted to a beneficial effect. The materials, meanwhile, may provide improved compression set and elastic recovery properties versus other polyolefin plastomers and elastomers. In various embodiments, olefin block copolymers may have both the flexibility of polyolefin plastomers and elastomers and the heat resistance of high density polyethylene.

[0022] As described above, in various embodiments, the high performance foams may contain a mixture of EVA, polyolefin elastomer (e.g., ENGAGE™), and/or olefin block copolymer (e.g., INFUSE™). In various embodiments, this mixture may produce a high-performance foam that has an increased resilience compared to traditional EVA foams. For example, in various embodiments, the high performance foam may have a resilience of 48-52% (for example, using the DIN 53512 test for determining the rebound resilience of rubber using the Schob pendulum published by the International Organization for Standardization (IOS); standard 45% min.), as compared to a resilience of about 45% (standard 40% min.) for EVA foam. In some embodiments, resilience may refer to the percentage of energy used to compress a foam that is recovered as mechanical work during expansion of the foam. In some

embodiments, resilience may be measured by dropping a missile from a known height onto the foam below, then measuring how high the missile rebounds.

[0023] In various embodiments, the high performance foams also may have reduced compression set when compared to traditional EVA foams. For example, in various embodiments, the compression set of the high performance foam may have a maximum of about 45%, whereas EVA foam may have a maximum of about 60% using the ASTM D-395 (B) Standard Test Method for Rubber Property - Compression Set, or the SATRA TM64 Compression Set – Constant Stress Method published by SATRA Technology Centre. In various embodiments, compression set may be measured as a percentage of original thickness of the sample, and may refer to the degree to which a sample loses some of its original dimensions due to permanent deformation.

[0024] In various embodiments, the high performance foams also may have a reduced shrinkage rate, as compared to EVA foams. For example, in various embodiments, the shrinkage rate of the high performance foam may be about 1% (70 Asker C, one hour), whereas EVA foam may have a shrinkage rate of about 1.5% (Comparable Example 1: 70 Asker C, 15 minutes; Comparable Example 2: 50 Asker C, 24 hours). Shrinkage may be measured in a variety of ways. In one example, a specimen may be heated to 70°C for 15 minutes, cooled to room temperature, and the resulting length and width are compared to the starting dimensions. In another example, a specimen may be heated to 50°C for 24 hours before length and width are measured.

[0025] **Figure 1** is a table illustrating the composition of one specific, non-limiting example of a high performance foam as compared to conventional EVA foam, in accordance with various embodiments. In the specific, non-limiting example illustrated in **Figure 1**, the high performance foam may include about 65-75 PHR (parts per hundred resin) of EVA (for instance, about 66-74 PHR, about 67-73 PHR, about 68-72 PHR, or about 69-71 PHR); about 15-25 PHR of a polyolefin elastomer (e.g., ENGAGE™) (for instance, about 16-24 PHR, about 17-23 PHR, about 18-22 PHR, or about 19-21 PHR); and about 5-20 PHR of an olefin block copolymer (e.g., INFUSE™) (for instance, about 7-18 PHR, about 9-16 PHR, or about 11-14 PHR). As used herein, the terms “PHR” and “parts per hundred resin” refer to the parts in weight of the referenced component in relation to the total weight of the plastics and other polymers in the formulation. For example, a foam that contains 350g of

polyolefin elastomer and 650g of EVA has a total “resin” weight of 1000g, with polyolefin elastomer at 35 PHR and EVA at 65 PHR. As used herein, the “resin” does not include additional ingredients, such as pigments, fillers, blowing agents, and/or crosslinking agents, and varying the amounts of these ingredients does not change the total resin weight for the purpose of calculating PHR.

[0026] In various embodiments, a high performance foam in accordance with the present disclosure also may include small amounts of pigments, fillers, blowing agents, and/or crosslinking agents. For example, in one specific, non-limiting example, a high performance form in accordance with the present disclosure may include about 1.25 to about 1.75 PHR of ZnO (for example, about 1.3-1.6 PHR, or about 1.1-1.4 PHR), about 0.3-0.7 PHR STA (stearic acid) (for example, about 0.4-0.6 PHR), about 5-15 PHR of filler, about 1.25-1.75 PHR of TiO₂ (for example, about 1.4-1.6 PHR), about 2.25-2.75 PHR of blowing agent (for example, about 2.4-2.6 PHR), and/or about 0.4-0.7 PHR of the crosslinker DCP (dicumyl peroxide; for example, about 0.5 to about 0.6 PHR).

[0027] As further illustrated in **Figure 1**, a high performance foam in accordance with the present disclosure may include about 70 PHR of EVA 18%, about 20 PHR of a polyolefin elastomer (e.g., ENGAGETM, for example ENGAGETM 8200), and about 10 PHR of olefin block copolymer (e.g., INFUSETM, such as INFUSETM 9107). In another specific, non-limiting example, a high performance foam in accordance with the present disclosure also may include about 1.5 PHR of ZnO, about 0.5 STA, about 10 PHR of filler, about 1.5 PHR of TiO₂, about 2.5 PHR of blowing agent, and/or about 0.5 PHR of DCP (crosslinker). In some embodiments, up to about 20 PHR of olefin block copolymer (e.g., INFUSETM) may be used. For example, in another specific, non-limiting embodiment, a high performance foam may include about 70 PHR of EVA, about 10 PHR of a polyolefin elastomer (e.g., ENGAGETM), and about 20 PHR of olefin block copolymer (e.g., INFUSETM). Another specific, non-limiting embodiment may include about 60 PHR of EVA, about 20 PHR of polyolefin elastomer (e.g., ENGAGETM), and about 20 PHR of olefin block copolymer (e.g., INFUSETM). In some embodiments, the stiffness and/or other performance elements of the footwear may be varied in order to suit a particular application. For example, to increase rebound, the amount of olefin block copolymer (e.g., INFUSETM) in the formula may be increased, whereas if a stiffer

midsole is desired, a harder EVA and/or olefin block copolymer (e.g., INFUSE™) formulation may be selected.

[0028] **Figure 2** is a table illustrating several properties of the high performance foam of **Figure 1**, as compared to conventional EVA foam, in accordance with various embodiments. In various embodiments, the polyolefins selected and the amounts used in the high performance foams may be varied in order to obtain a desired resilience, density, hardness, tensile strength, shrinkage, or other properties. In the specific, non-limiting example illustrated in **Figure 2**, the high performance foam formulation produces a foam with characteristics that are superior to those of traditional EVA foams. For example, the illustrated foam has a hardness (Asker C) of 53, versus 55 for EVA foam; a density of 0.22 g/cm³, versus 0.23 g/cm³ for EVA foam; and a resilience of 48% versus 43% for EVA foam. The illustrated foam also has a tensile strength of 31.1 kg/cm² versus 30 kg/cm² for EVA foam, and both the illustrated foam and the EVA foam have a bonding strength with a substrate of greater than 25 N/cm, both pass the Ross Flex cracking test (e.g., ASTM D1052) with greater than 50,000 times with no damage, the illustrated foam has a compression set of 43%, as compared to a compression set of 55% for EVA foam, and the illustrated foam has a shrinkage rate of 0.8%, versus 1.2% for EVA foam.

[0029] Although the exemplary foams illustrated in **Figures 1** and **2** include more than one polyolefin, one of skill in the art will appreciate that single polyolefins may be used. For instance, in one example, a high performance foam may include 25-50 PHR or more polyolefin elastomer (e.g., ENGAGE™), and no olefin block copolymer (e.g., INFUSE™). Similarly, in another example, a high performance foam may include 25-50 PHR or even more of olefin block copolymer (e.g., INFUSE™), and no polyolefin elastomer (e.g., ENGAGE™).

Although certain embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate and/or equivalent embodiments or implementations calculated to achieve the same purposes may be substituted for the embodiments shown and described without departing from the scope. Those with skill in the art will readily appreciate that embodiments may be implemented in a very wide variety of ways. This application is intended to cover any adaptations or variations of the embodiments discussed herein. Therefore, it is manifestly intended that embodiments be limited only by the claims and the equivalents thereof.

Claims

What is claimed is:

1. A high performance foam for a midsole comprising:
at least 15 parts per hundred resin (PHR) polyolefin elastomer;
at least 5 PHR olefin block copolymer; and
no more than 75 PHR ethylene vinyl acetate (EVA).
2. The high performance foam of claim 1, comprising:
15-25 PHR polyolefin elastomer;
5-20 PHR olefin block copolymer; and
65-75 PHR EVA.
3. The high performance foam of claim 1, comprising 18-22 PHR polyolefin elastomer.
4. The high performance foam of claim 1, comprising 9-16 PHR olefin block copolymer.
5. The high performance foam of claim 1, comprising 68-72 PHR EVA.
6. The high performance foam of claim 1, comprising:
18-22 PHR polyolefin elastomer;
9-16 PHR olefin block copolymer; and
68-72 PHR EVA.
7. The high performance foam of claim 1, comprising:
20 PHR polyolefin elastomer;
20 PHR olefin block copolymer; and
60 PHR EVA.
8. The high performance foam of claim 1, comprising:
20 PHR polyolefin elastomer;
10 PHR olefin block copolymer; and

70 PHR EVA.

9. The high performance foam of claim 1, wherein the EVA is EVA 18%.
10. The high performance foam of claim 1, wherein the high performance foam has a compression set of less than 45%, a resilience of greater than 45%, and a bonding strength of greater than 25 N/cm.
11. A high performance foam for a midsole, comprising:
ethylene vinyl acetate (EVA); and
25-50 PHR homogeneously branched, linear or substantially linear ethylene/alpha-olefin polymer, wherein the homogeneously branched, linear or substantially linear ethylene/alpha-olefin polymer has a density of from 0.85-0.92 g/cm³, and a melt index of 0.1-10 g/10 min.
12. The high performance foam of claim 11, wherein the homogeneously branched, linear or substantially linear ethylene/alpha-olefin polymer comprises a polyolefin elastomer and/or an olefin block copolymer.
13. The high performance foam of claim 11, wherein the high performance foam has a compression set of less than 45%.
14. The high performance foam of claim 11, wherein the high performance foam has a resilience of greater than 45%.
15. The high performance foam of claim 11, wherein the high performance foam has a bonding strength of greater than 25 N/cm.
16. The high performance foam of claim 11, wherein the high performance foam has a compression set of less than 45%, a resilience of greater than 45%, and a bonding strength of greater than 25 N/cm.
17. A high performance foam for a midsole comprising:
at least 15 PHR polyolefin; and

no more than 75 PHR ethylene vinyl acetate (EVA), wherein the high performance foam has a compression set of less than 45%, a resilience of greater than 45%, and a bonding strength of greater than 25 N/cm.

18. The high performance foam of claim 17, comprising:
15-50 PHR polyolefin.
19. The high performance foam of claim 17, wherein the polyolefin comprises a polyolefin elastomer and/or an olefin block copolymer.
20. A method of making a high performance midsole comprising:
mixing ethylene vinyl acetate (EVA), a polyolefin elastomer, and an olefin block copolymer to form an EVA/polyolefin mixture; and
compression molding the EVA polyolefin mixture to form the midsole.
21. The method of claim 20, wherein mixing the EVA, polyolefin elastomer, and olefin block copolymer comprises mixing 65-75 PHR EVA, 15-25 PHR polyolefin elastomer, and 5-20 PHR olefin block copolymer.

High Performance Foam Formulation			Conventional EVA Foam	
Raw Material	PHR*	Range (PHR)	Raw Material	PHR
EVA 18%	70	65-75	EVA 18%	100
Engage 8200	20	15-25	/	/
Infuse 9107	10	05-20	/	/
ZnO	1.5	1.25-1.75	ZnO	1.5
STA	0.5	0.3-0.7	STA	0.5
Filler	10	5-15	Filler	10
TiO2	1.5	1.25-1.75	TiO2	1.5
Other pigment	/	/	Other pigment	/
Blowing agent	2.5	2.25-2.75	Blowing agent	2.5
DCP (Crosslinker)	0.5	0.4-0.7	DCP (Crosslinker)	0.5

*Parts per hundred resin

Figure 1

Test	High Performance Foam Formulation	Conventional EVA Foam
	MCS# Pol-EVA011 (CMP)	EVA-001 (CMP)
Hardness (Asker C) 55 ±2 C	53	55
Density (g/cm ³) 0.21-0.25	0.22	0.23
Resilience (%) >45%	48	43
Tensile strength >20kg/cm ²)	31.1	30
Elongation at break >250%	283.7	310
C-Tear strength >12kg/cm	16	18
Split tear strength >25N/cm	27	30
Bonding strength with substrate >25N/cm	Pass	Pass
Ross Flex-cracking test >50,000 times no damage	Pass	Pass
Compression set < 45%	43%	55
Shrinkage <1.5%	0.8	1.2
Non-yellow Test >4-5	5	5

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/047167**A. CLASSIFICATION OF SUBJECT MATTER****A43B 13/40(2006.01)i, A43B 13/04(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)

A43B 13/40; C08K 3/00; C08J 9/228; C08L 75/04; C08L 25/02; C08F 8/00; C08L 31/04; C08J 9/00; C08L 23/08; A43B 13/04

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

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: midsole, ethylene vinyl acetate, polyolefin elastomer, olefin block copolymer, INFUSE, ENGAGE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010-0048752 A1 (VIGNOLA, E. et al.) 25 February 2010 See paragraphs [0046], [0084], [0086], [0120], [0121], [0132], claims 1, 4, 8, 9.	11-19
Y		1-10, 20, 21
Y	US 2009-0275690 A1 (WEAVER, L. B. et al.) 05 November 2009 See paragraphs [0122], [0137], [0241], claim 40.	1-10, 20, 21
A	US 2002-0143077 A1 (SUEDA, T. et al.) 03 October 2002 See abstract, claims 1, 2, 10, 14, 15.	1-21
A	WO 2012-000877 A1 (DOW GLOBAL TECHNOLOGIES LLC et al.) 05 January 2012 See abstract.	1-21
A	KR 10-0619287 B1 (LEE, S. Y. et al.) 25 August 2006 See abstract, claims 1, 12-14.	1-21
A	US 2008-0161438 A1 (WANG, X. et al.) 03 July 2008 See abstract, claims 1, 17, 18.	1-21



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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Date of the actual completion of the international search

26 September 2013 (26.09.2013)

Date of mailing of the international search report

07 October 2013 (07.10.2013)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010-0048752 A1	25/02/2010	AU 2009-282898 A1 CA 2734132 A1 CN 102171281 A EP 2315796 A1 EP 2315796 A4 JP 2012-50032 7A KR 10-2011-0044313 A MX 2011001806 A TW 201016774 A WO 2010-022208 A1	25/02/2010 25/02/2010 31/08/2011 04/05/2011 30/05/2012 05/01/2012 28/04/2011 24/03/2011 01/05/2010 25/02/2010
US 2009-0275690 A1	05/11/2009	AR 063767 A1 AR 063768 A1 AR 063769 A1 AT 461241 T CA 2668142 A1 CA 2668397 A1 CN 101573406 A CN 101611086 A CN 101616983 A DE 602007005398 D1 EP 2078055 A2 EP 2079796 A2 EP 2079796 B1 EP 2084222 A2 EP 2084222 B1 JP 2010-508423 A JP 2010-508424 A JP 2010-509407 A KR 10-2009-0077005 A KR 10-2009-0077006 A KR 10-2009-0077010 A TW 200835736 A TW 200835737 A TW 200837123 A TW 200904889 A US 2010-0028568 A1 US 2010-0055358 A1 US 8124234 B2 US 8404780 B2 WO 2008-057878 A2 WO 2008-057878 A3 WO 2008-057881 A2 WO 2008-057881 A3 WO 2008-057886 A2 WO 2008-057886 A3 WO 2009-017868 A1	18/02/2009 18/02/2009 18/02/2009 15/04/2010 15/05/2008 15/05/2008 04/11/2009 23/12/2009 30/12/2009 29/04/2010 15/07/2009 22/07/2009 01/08/2012 05/08/2009 17/03/2010 18/03/2010 18/03/2010 25/03/2010 13/07/2009 13/07/2009 13/07/2009 01/09/2008 01/09/2008 16/09/2008 01/02/2009 04/02/2010 04/03/2010 28/02/2012 26/03/2013 15/05/2008 31/07/2008 15/05/2008 31/07/2008 15/05/2008 31/07/2008 05/02/2009
US 2002-0143077 A1	03/10/2002	CN 1252171 C0	19/04/2006

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/047167

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		CN 1369520 A0	18/09/2002
		DE 60200956 D1	23/09/2004
		DE 60200956 T2	18/08/2005
		EP 1229076 A1	07/08/2002
		EP 1229076 B1	18/08/2004
		JP 2002-302565 A	18/10/2002
		KR 10-0456392 B1	10/11/2004
		KR 10-2002-0064176 A	07/08/2002
		TW 574296 A	01/02/2004
		US 6720364 B2	13/04/2004
WO 2012-000877 A1	05/01/2012	CN 102959013 A	06/03/2013
		EP 2588534 A1	08/05/2013
		IT MI20101182 A1	31/12/2011
		JP 2013-530286 A	25/07/2013
		SG 186719 A1	28/02/2013
		US 2013-0096259 A1	18/04/2013
KR 10-0619287 B1	01/09/2006	None	
US 2008-0161438 A1	03/07/2008	CN 101589096 A	25/11/2009
		TW 200829642 A	16/07/2008
		WO 2008-082442 A1	10/07/2008