(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 January 2008 (31.01.2008)

PCT

(10) International Publication Number
WO 2008/013371 A1

(51) International Patent Classification:
H01M 10/04 (2006.01)

(21) International Application Number:
PCT/KR2007/003411

(22) International Filing Date: 14 July 2007 (14.07.2007)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
10-2006-0068823 24 July 2006 (24.07.2006) KR

(71) Applicant *(for all designated States except US)*: **LG CHEM, LTD.** [KR/KR]; 20, Yoido-dong, Youngdungpo-gu, Seoul 150-721 (KR).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **RYU, Ji Heon** [KR/KR]; 460-15, Beon 1-dong, Gangbuk-gu, Seoul 142-865 (KR). **LEE, Eun Ju** [KR/KR]; 406, 158, Mannyeon-dong, Seo-gu, Daejeon 302-834 (KR). **CHOI, Jeong Hee** [KR/KR]; 102-103, Daewoo Apt., 1170-2, Daeyeon 4-dong, Nam-gu, Busan 608-794 (KR). **SHIN, Youngjoon** [KR/KR]; 105-904, Expo Apt., Jeonmin-dong, Yuseong-gu, Daejeon 305-761 (KR).

(74) Agent: **SOHN, Chang Kyu**; 1403, Seongji Heights 2-cha Bldg., 642-16, Yoksam 1-dong, Kangnam-gu, Seoul 135-910 (KR).

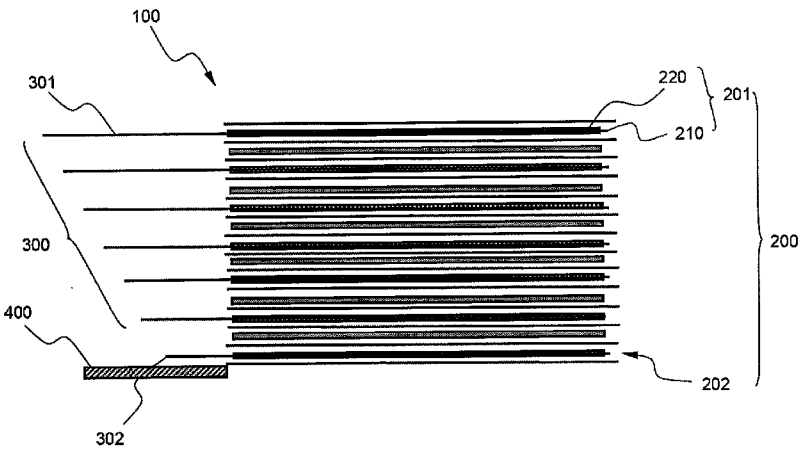
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** ELECTRODE ASSEMBLY HAVING ELECTRODE TABS OF THE SAME SIZE IN JOINT PORTION THEREOF AND ELECTROCHEMICAL CELL CONTAINING THE SAME



(57) **Abstract:** Disclosed herein is a stacking or stacking/folding type electrode assembly of a cathode/separator/anode structure, wherein the electrode assembly is constructed in a structure in which tabs (electrode tabs), having no active material applied thereto, protrude from electrode plates constituting the electrode assembly, electrode leads are located at one-side ends of the stacked electrode tabs such that the electrode leads are electrically connected to the electrode tabs, and protruding lengths of the electrode tabs are gradually increased according to the distances between the electrode leads and the electrode tabs, whereby the lengths of the electrode tabs at joint portions between the electrode tabs and the electrode leads are the same. Also disclosed is an electrochemical cell including the electrode assembly.

WO 2008/013371 A1

ELECTRODE ASSEMBLY HAVING ELECTRODE TABS OF THE SAME SIZE IN JOINT PORTION THEREOF AND ELECTROCHEMICAL CELL CONTAINING THE SAME

FIELD OF THE INVENTION

The present invention relates to an electrode assembly having electrode tabs of the same size in a joint portion thereof, and, more particularly, to a stacking or stacking/folding type electrode assembly of a cathode/separator/anode structure, wherein the electrode assembly is constructed in a structure in which tabs (electrode tabs), having no active material applied thereto, protrude from electrode plates constituting the electrode assembly, electrode leads are located at one-side ends of the stacked electrode tabs such that the electrode leads are electrically connected to the electrode tabs, and protruding lengths of the electrode tabs are gradually increased according to the distances between the electrode leads and the electrode tabs, whereby the lengths of the electrode tabs at joint portions between the electrode tabs and the electrode leads are the same.

BACKGROUND OF THE INVENTION

As mobile devices have been increasingly developed, and the demand for such mobile devices has increased, the demand for batteries has also sharply increased as an

energy source for the mobile devices. Also, much research on batteries satisfying various needs has been carried out.

In terms of the shape of batteries, the demand for prismatic secondary batteries or pouch-shaped secondary batteries, which are thin enough to be applied to products, such as mobile phones, is very high. In terms of the material for batteries, on the other hand, the demand for lithium secondary batteries, such as lithium ion batteries and lithium ion polymer batteries, having high energy density, high discharge voltage, and high output stability, is very high.

Furthermore, secondary batteries may be classified based on the construction of an electrode assembly having a cathode/separator/anode structure. For example, the electrode assembly may be constructed in a jelly-roll (winding) type structure in which long-sheet type cathodes and long-sheet type anodes are wound while separators are disposed respectively between the cathodes and the anodes, a stacking type structure in which pluralities of cathodes and anodes having a predetermined size are successively stacked while separators are disposed respectively between the cathodes and the anodes, or a stacking/folding type structure in which pluralities of cathodes and anodes having a predetermined size are successively stacked while separators are disposed respectively between the cathodes and the anodes to constitute a bi-cell or a full-cell, and then the bi-cell or the full-cell is wound.

FIG. 1 is a side view typically illustrating the general structure of a conventional representative stacking type electrode assembly.

Referring to FIG. 1, the stacking type electrode assembly 10 is constructed in a structure in which cathodes 20, each of which has a cathode active material 22 applied to the opposite major surfaces of a cathode current collector 21, and anodes

30, each of which has an anode active material 32 applied to the opposite major surfaces of an anode current collector 31, are sequentially stacked while separators 70 are disposed respectively between the cathodes 20 and the anodes 30.

From one-side ends of the cathode current collectors 21 and the anode current collectors 31 protrude pluralities of cathode tabs 41 and anode tabs 51, to which an active material is not applied, such that the cathode tabs 41 and the anode tabs 51 are electrically connected to a cathode lead 60 and an anode lead (not shown) constituting electrode terminals of a battery (not shown). The cathode tabs 41 and the anode tabs 51 are joined in a concentrated state, and are then connected to the cathode lead 60 and the anode lead, respectively. This structure is more clearly illustrated in FIG. 2, which is a partially enlarged view typically illustrating the joint portion between the cathode tabs and the cathode lead. FIG. 2 illustrates only the joint portion between the cathode tabs and the cathode lead for convenience of description, although this structure is also applied to the joint portion between the anode tabs and the anode lead.

Referring to FIG. 2, the cathode tabs 40 are brought into tight contact with each other in the direction indicated by an arrow, and are connected to the cathode lead 60. Specifically, the cathode tabs 40 are brought into tight contact with the cathode lead 60 adjacent to the lowermost cathode tab 42 such that the cathode tabs 40 are joined to each other with the smallest bending length. Consequently, the length difference occurs at a joint portion A of the cathode tabs 40 between the lowermost cathode tab 42, which is a short distance from the cathode lead 60, and the uppermost cathode tab 41, which is a long distance from the cathode lead 60, due to the distance difference between the cathode tabs 40 and the cathode lead 60. Of course, this length difference also occurs at a joint portion between the anode tabs and the anode lead.

Due to this structure, the areas where the electrode tabs are in contact with the electrode lead are different from each other at the joint portion between the electrode tabs and the electrode lead of the electrode assembly, with the result that the use of electrode leads having more than a necessary size is inevitable. This is because the size of the electrode lead is set based on the electrode tab having the largest contact area so as to fix the electrode tabs, the thickness of which is much less than the electrode lead. In addition, the structural stability of the electrode assembly having the above-described structure is lowered for this reason.

In order to solve the above-mentioned problem, there has been proposed a technology for joining electrode tabs, while the electrode tabs are in tight contact with each other in one direction, and uniformly cutting the electrode tabs using a cutter. When using this technology, however, burrs occur at the cut ends of the electrode tabs, when the electrode tabs are cut. In addition, it is necessary to additionally perform a cutting process.

On the other hand, it is possible to bend the end of the electrode lead to a predetermined angle, the short-distance electrode tab to a large angle, and the long-distance electrode tab to a small angle in order to reduce the length difference between the electrode tabs at the joint portion thereof. In this structure, however, the size of the joint portion between the electrode tabs and the electrode lead is increased due to the bending, with the result that the electrode assembly may move, when external impacts are applied to the electrode assembly, and therefore, a possibility of the occurrence of a short circuit is strong. Especially for a middle- or large-sized battery cell, the thickness of the electrode lead is approximately twice that of a small-sized battery cell, with the result that it is more difficult to apply the above-described structure.

Consequently, there is a high necessity for an electrode assembly having an improved structure in which the lengths of the electrode tabs at the joint portion thereof are the same while the bending of the electrode tabs is minimized.

SUMMARY OF THE INVENTION

Therefore, the present invention has been made to solve the above problems, and other technical problems that have yet to be resolved.

Specifically, it is an object of the present invention to provide an electrode assembly having a structure in which the lengths of electrode tabs at a joint portion between the electrode tabs and an electrode lead are the same while the bending of the electrode tabs is minimized.

It is another object of the present invention to provide an electrode assembly having a structure in which the joining between the electrode tabs and the electrode lead is stably performed while the size of the electrode lead is small.

It is a further object of the present invention to provide an electrochemical cell including the electrode assembly.

In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of a stacking or stacking/folding type electrode assembly of a cathode/separator/anode structure, wherein the electrode assembly is constructed in a structure in which tabs (electrode tabs), having no active material applied thereto, protrude from electrode plates constituting the electrode assembly, electrode leads are located at one-side ends of the stacked electrode tabs such that the electrode leads are electrically connected to the electrode tabs, and protruding lengths of the electrode tabs are gradually increased according to the distances between

the electrode leads and the electrode tabs, whereby the lengths of the electrode tabs at joint portions between the electrode tabs and the electrode leads are the same.

According to the present invention, the electrode leads are not particularly restricted so long as the electrode leads are made of a material that can be electrically connected to the electrode tabs. Preferably, the electrode leads are made of a metal plate. The metal plate may be selected from a group consisting of an aluminum plate, a copper plate, a nickel plate, a copper plate coated with nickel, and a SUS plate.

Also, the electrode leads are not particularly restricted so long as the electrode leads are constructed in a structure in which the electrode leads are easily connected to the electrode tabs. For example, the electrode leads may be formed in the shape of a straight line in vertical section, and the electrode leads are joined to the electrode tabs by welding. The electrode leads may be connected to the electrode tabs in various manners. Preferably, the electrode leads are more stably connected to the electrode tabs by welding. The welding may include ultrasonic welding, laser welding, and resistance welding.

In the present invention, the one-side end of the stacked electrode tabs, where each electrode lead is preferably located, means the upper-side end of the electrode tab located at the uppermost position in the direction in which the electrode tabs are stacked (the uppermost electrode tab) or the lower-side end of the electrode tab located at the lowermost position in the direction in which the electrode tabs are stacked (the lowermost electrode tab). Consequently, the direction in which the protruding lengths of the electrode tabs are increased may be changed depending upon which side end of the stacked electrode tabs each electrode lead is located at. For example, when each electrode lead is located at the upper-side end of the uppermost electrode tab, it is

preferable that the protruding lengths of the electrode tabs be gradually increased from the uppermost electrode tab to the lowermost electrode tab.

In accordance with another aspect of the present invention, there is provided an electrochemical cell including the electrode assembly with the above-stated construction.

The electrochemical cell is one that provides electricity through an electrochemical reaction. For example, the electrochemical cell may be an electrochemical secondary battery or an electrochemical capacitor. Especially, the electrochemical cell is preferably applied to a lithium secondary battery.

The secondary battery includes an electrode assembly that can be charged and discharged. Preferably, the secondary battery is constructed in a structure in which an electrode assembly is mounted in a battery case made of a laminate sheet including a metal layer and a resin layer in a sealed state. The secondary battery with the above-described structure may be referred to as a pouch-shaped secondary battery.

Also, the secondary battery is preferably used as a unit cell for high-output, large-capacity battery packs.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a typical view illustrating the general structure of a conventional stacking type electrode assembly;

FIG. 2 is an enlarged view illustrating the connection between cathode tabs, joined to each other in a concentrated state, and a cathode lead of the electrode assembly shown in FIG. 1;

FIG. 3 is a typical view illustrating the structure of a stacking type electrode assembly according to a preferred embodiment of the present invention; and

FIG. 4 is an enlarged view illustrating the connection between cathode tabs, joined to each other in a concentrated state, and a cathode lead of the electrode assembly shown in FIG. 3.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Now, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. It should be noted, however, that the scope of the present invention is not limited by the illustrated embodiments.

FIG. 3 is a typical view illustrating the structure of a stacking type electrode assembly according to a preferred embodiment of the present invention. The electrode assembly of FIG. 3 is approximately identical to the conventional electrode assembly, which is being generally used, and therefore, only the characteristics of the present invention will be described hereinafter. FIG. 3 illustrates only cathode tabs for convenience of description, although this structure is also applied to anode tabs.

Referring to FIG. 3, the electrode assembly 100 includes cathode plates 200 having cathode tabs 300 the protruding lengths of which are different. The respective cathode tabs 300 protrude from cathode current collectors 210 while a cathode active material 220 is not applied to the respective cathode tabs 300.

The cathode plates 200 are stacked in a structure in which a cathode plate 202 having a cathode tab 302, the protruding length of which is the smallest is located at the lowermost position, and a cathode plate 201 having a cathode tab 301, the protruding length of which is the largest is located at the uppermost position, such that the protruding lengths of the cathode tabs 300 are gradually increased from the lowermost position to the uppermost position. At this time, a cathode lead 400, which is joined to the cathode tabs 300, is located adjacent to the bottom of the cathode tab 302 protruding from the cathode plate 202 located at the lowermost position. Consequently, the cathode tabs 300 are brought into tight contact with each other in the direction in which the cathode lead 400 is located such that the cathode tabs 300 are joined to each other with the minimum bending length. This structure is more clearly illustrated in FIG. 4, which is a partially enlarged view typically illustrating the joint portion between the cathode tabs and the cathode lead.

Referring to FIG. 4, the cathode tabs 300 are brought into tight contact with each other in the direction indicated by an arrow, and are then connected to the cathode lead 400. At this time, the cathode tab 302, located at the lowermost position, is little bent, and the bending angle is gradually increased toward the cathode tab 301, located at the uppermost position. Consequently, the cathode tabs 300 have the same joint length L_3 at a joint portion B due to the difference between the bending angles, although the cathode tabs 300 have different protruding lengths.

The joint length L_3 corresponds to the length of the lowermost cathode tab 302, which is little bent. Consequently, the joint length L_3 is less than the joint length L_1 set based on the lowermost cathode tab 42 having the largest length at the joint portion A, as shown in FIG. 2. As a result, the length L_4 of the cathode lead,

corresponding to the joint length L_3 of the cathode tabs 300, is also less than the length L_2 of the cathode lead as shown in FIG. 2.

On the other hand, the cathode tabs 300 are bent based on the lowermost cathode tab 302, which is little bent, and therefore, the cathode tabs 300 have the smallest bending length L_5.

Hereinafter, examples of the present invention will be described in more detail. It should be noted, however, that the scope of the present invention is not limited by the illustrated examples.

[Example 1]

A cathode active material containing lithium and an anode active material containing graphite were applied to opposite major surfaces of an aluminum foil and a copper foil, respectively, and then the aluminum foil and the copper foil were cut such that tab parts, of the cut aluminum foils and the cut copper foils, to which the active materials were not applied, had gradually increased lengths. Subsequently, the cut aluminum foils and the cut copper foils were stacked using separators in the structure shown in FIG. 3. After that, the tab parts of the cut aluminum foils and the cut copper foils were brought into tight contact with each other, as shown in FIG. 4, in the direction in which the cut aluminum foils and the cut copper foils were stacked, and were connected to corresponding electrode leads to manufacture an electrode assembly.

[Comparative example 1]

An electrode assembly was manufactured in the same method as Example 1 except that the aluminum foil and the copper foil were cut such that tab parts, of the cut

aluminum foils and the cut copper foils, to which the active materials were not applied, had the same length.

The tab ends of the electrode assembly manufactured according to Example 1 and Comparative example 1 were observed, using a microscope, to inspect the surface state thereof. The observation results revealed that burrs were formed at the cut ends of the electrode assembly according to Comparative example 1, the electrode tabs of which were cut with the same length. As previously described, the burrs damage the corresponding regions of the battery case, during the assembly or the use of a battery, with the result that a short circuit may occur in the battery or an electrolyte may leak from the battery.

INDUSTRIAL APPLICABILITY

As apparent from the above description, the electrode assembly according to the present invention has the following effects. The electrode assembly is constructed in a structure in which the lengths of electrode tabs at a joint portion between the electrode tabs and an electrode lead are the same while the bending of the electrode tabs is minimized. Furthermore, the electrode assembly is constructed in a structure in which the joining between the electrode tabs and the electrode lead is stably performed while the size of the electrode lead is small.

Although the preferred embodiment of the present invention has been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. A stacking or stacking/folding type electrode assembly of a cathode/separator/anode structure, wherein the electrode assembly is constructed in a structure in which tabs (electrode tabs), having no active material applied thereto, protrude from electrode plates constituting the electrode assembly, electrode leads are located at one-side ends of the stacked electrode tabs such that the electrode leads are electrically connected to the electrode tabs, and protruding lengths of the electrode tabs are gradually increased according to the distances between the electrode leads and the electrode tabs, whereby the lengths of the electrode tabs at joint portions between the electrode tabs and the electrode leads are the same.

2. The electrode assembly according to claim 1, wherein the electrode leads are made of a metal plate.

3. The electrode assembly according to claim 2, wherein the metal plate is selected from a group consisting of an aluminum plate, a copper plate, a nickel plate, a copper plate coated with nickel, and a SUS plate.

4. The electrode assembly according to claim 1, wherein the electrode leads are formed in the shape of a straight line in vertical section, and the electrode leads are joined to the electrode tabs by welding.

5. An electrochemical cell including an electrode assembly according to any one of claims 1 to 4.

6. The electrochemical cell according to claim 5, wherein the electrochemical cell is a secondary battery or a capacitor.

7. The electrochemical cell according to claim 6, wherein the secondary battery is constructed in a structure in which an electrode assembly is mounted in a battery case made of a laminate sheet including a metal layer and a resin layer in a sealed state.

8. The electrochemical cell according to claim 7, wherein the secondary battery is a unit cell for high-output, large-capacity battery packs.

DRAWINGS

FIG. 1

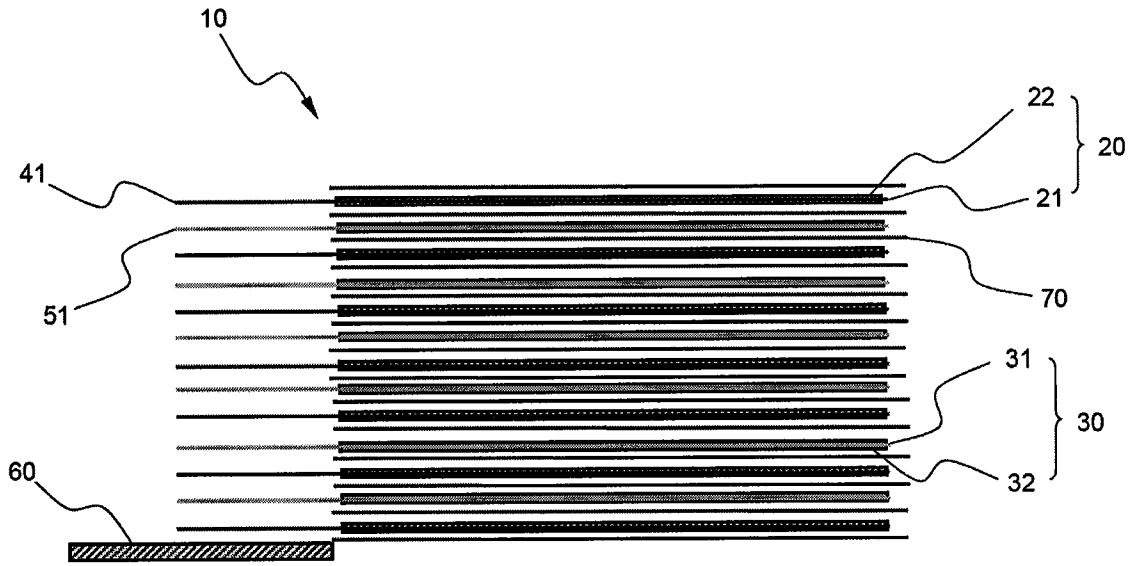


FIG. 2

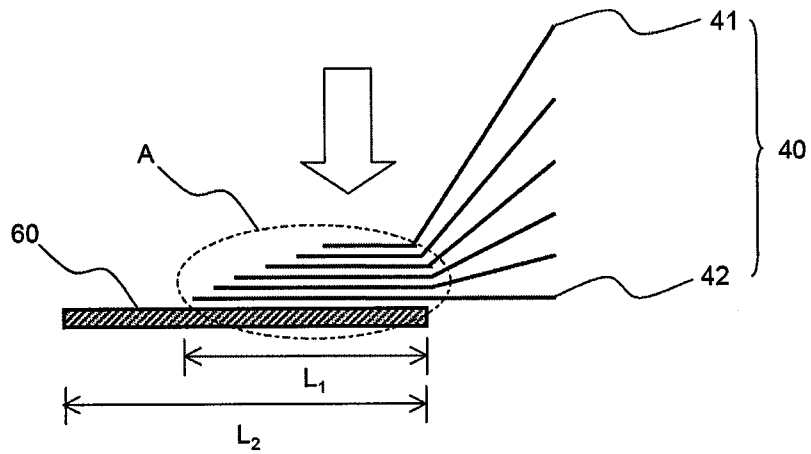


FIG. 3

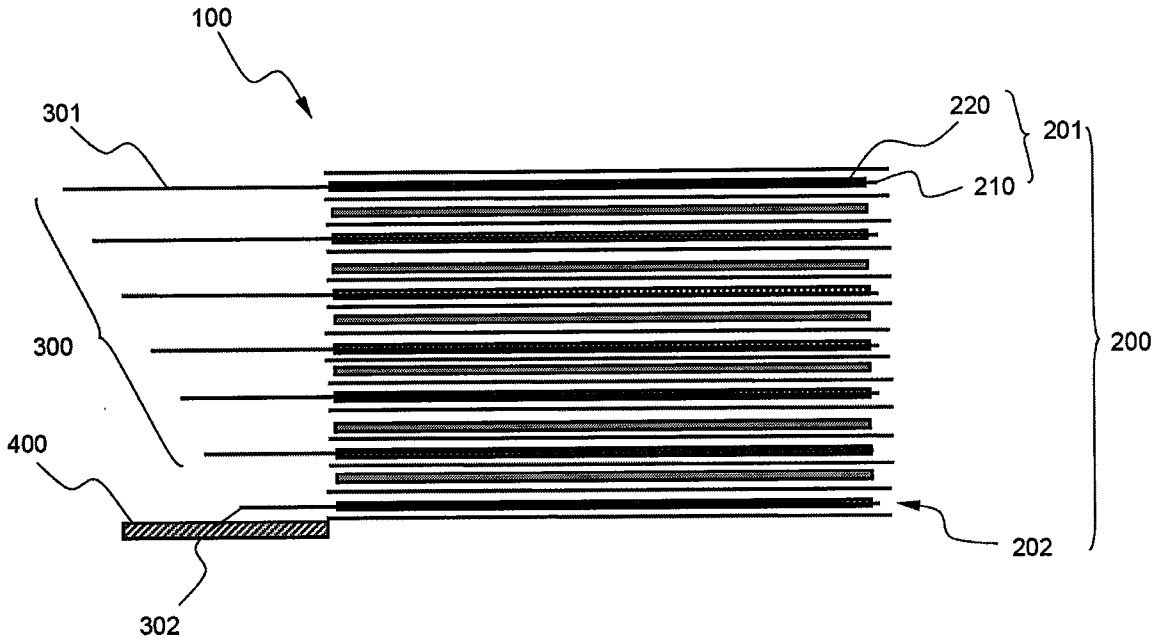
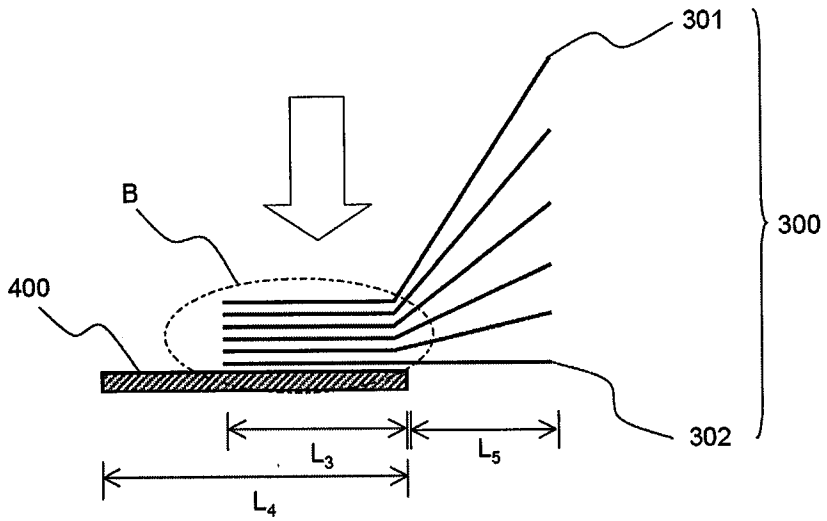


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/003411

A. CLASSIFICATION OF SUBJECT MATTER

H01M 10/04(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)

IPC 8 : H01M 10/04

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 since 1975
Japanese Utility models and applications for Utility models since 1975

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

eKIPASS (KIPO internal) "tabs", "length"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 06849358 B2(RONALD O' CONNELL.) 01 February 2005 See abstract, columns 3-6, claims 1-3, figures 1-5.	1-8
A	US 06423442 B1 (PAUL T. HALLIFAX et al.) 23 July 2002 See abstract, columns 3-5, claims 1-30, figures 1-9.	1-8
A	JP 15123743 A (SONY CORP.) 25 April 2003 See abstract, paragraphs [0005]- [0050], claims 1-6, figures 1-18.	1-8
A	KR 1020030095519 A(KOKAM ENGINEERING CO., LTD.) 24 December 2003 See abstract, pages 2-4, claims 1-8, figures 1-7.	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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"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
"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
08 OCTOBER 2007 (08.10.2007)	**08 OCTOBER 2007 (08.10.2007)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
CHOI Byung Chul
Telephone No. 82-42-481-8402

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2007/003411

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US06849358B2	01.02.2005	US20020146620A1	10.10.2002
US06423442B1	23.07.2002	US20020022175A1	21.02.2002
JP15123743A	25.04.2003	None	
KR1020030095519A	24.12.2003	CN1326260C	11.07.2007
		CN1941491A	04.04.2007
		EP01387419A2	04.02.2004
		EP01387419A3	07.04.2004
		JP2004022534A2	22.01.2004
		TW222233B	11.10.2004
		US20030232243A1	18.12.2003
		US2006286454AA	21.12.2006