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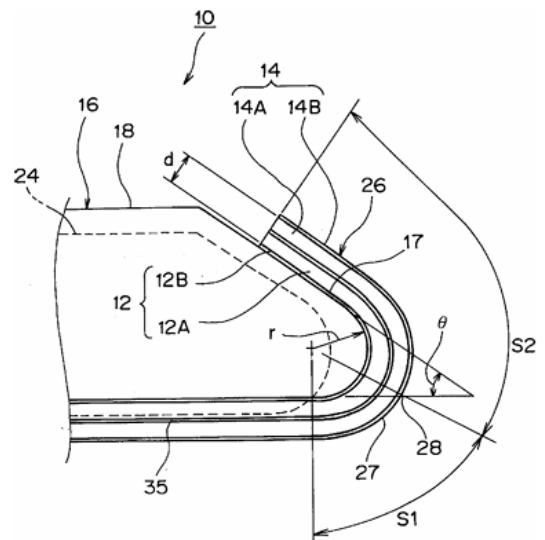
(21) Application no.	Patent application 2000-207656 (P2000-207656)	(71) Applicant	000006688 2-3-21 Kosobecho, Takatsuki, Osaka Prefecture Yuasa Corporation
(22) Date of application	07/10/2000	(72) Inventor	Morikatsu Arai 2-3-21 Kosobecho, Takatsuki, Osaka Prefecture Yuasa Corporation
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(54) [Name of invention] Sealed type battery

(57) [Summary]

[Issue] To provide a sealed type battery that simplifies the bending process of the sealing section, enhances volumetric energy density, and eliminates the risk of cracks occurring in the metal layer of the metal resin composite film.

[Means of resolution] The sealed type battery 10 has a housing projection 16 formed on one metal resin composite film 12, and a power generation element 24 is housed in this housing projection 16. The other metal resin composite film 14 is superimposed on the metal resin composite film 12 that houses the power generation element 24, and the inner surfaces of the superimposed pair of metal resin composite films 12 and 14 are fused together and sealed. At least a part of the fused sealing section 26 is bent to follow side surface 17 of the housing projection 16, and this sealing section 26 is set so that it does not extend beyond top surface 18 of the housing projection 16, and the elongation rate a of the metal layer (12A, 14A) at the bent section 27 of the sealing section 26 is set so as not to exceed 1.5.



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[Scope of patent claims]

[Claim 1] A sealed type battery comprising: a metal resin composite film in which a metal layer and a resin layer are laminated; a housing projection formed in a section of said metal resin composite film; a power generation element housed within said housing projection, said power generation element having a positive electrode and a negative electrode laminated via an electrolyte layer; a second metal resin composite film superimposed upon the first metal resin composite film containing said power generation element; a fused seal formed between the inner surfaces of the superimposed pair of metal resin composite films; and a configuration wherein at least a section of said fused seal is bent to follow the side surface of said housing projection, such that said fused seal does not extend beyond the ceiling surface of said housing projection; characterized in that, regarding said fused seal, where d represents the interplanar spacing between the metal layer surface of the first metal resin composite film and the metal layer surface of the second metal resin composite film, r represents the curvature radius of the bent section of the sealing section, and θ represents the bending angle of the sealing section, and where the elongation rate a of the metal layer at the bent section is expressed by the following formula, the sealed type battery is configured such that said elongation rate a of the metal layer does not exceed 1.5.

[Formula 1]

$$a = 1 + \frac{d \cdot (\pi - \theta)}{(2r + d) \cdot (\pi - \theta) + 2d}$$

[Claim 2] The sealed type battery according to Claim 1, wherein a section or the entirety of the bent section of said seal section constitutes an unadhered section in which the respective metal resin composite films are not adhered to one another, and the extent of this unadhered section is set within a range not exceeding 1 mm from the boundary between the adhered section and the unadhered section.

[Detailed description of the invention]

[0001]

(2)

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[Technical field to which the invention pertains]

The present invention relates to sealed type batteries, in particular, to sealed type batteries having a thickness of 4 mm or less.

[0002]

[Prior art] Due to their thin profile and high energy density, lithium-ion batteries are widely utilized as power sources for portable electronic devices; consequently, there is an ongoing demand for further increases in capacity and reductions in thickness. The configurations of these small-scale secondary batteries typically fall into two categories: cylindrical batteries, in which a wound electrode assembly (power generation element) is housed within a cylindrical case; and prismatic batteries, in which a power generation element comprising stacked flat electrode plates is housed within a rectangular case. As a means of providing smaller, lighter, and more cost-effective secondary batteries, proposals have been advanced—for instance, in Japanese unexamined utility model application 60-162362 and Japanese unexamined patent application 61-206157—suggesting a structure in which the power generation element is enclosed within a pouch made of an aluminum-metal/resin composite film and sealed via heat fusion.

[0003] In particular, in thin, sealed type batteries with a thickness of 4 mm or less, the thickness of the exterior casing significantly impacts the energy density. Consequently, thin type batteries frequently utilize exterior casings made of metal resin composite films, which have a thickness dimension ranging from one-fifth to one-third that of conventional metal cans. In sealed type batteries employing such metal resin composite film casings, the edges of the composite film are overlapped to form a sealing section adhered by an adhesive layer; to prevent oxygen and moisture from permeating through this adhesive layer and entering the interior of the battery,

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the width of the sealing section is established at a certain substantial dimension.

[0004] Consequently, the area of the sealing section occupies at least approximately 4% of the total area of a thin type battery, thereby significantly impacting the battery's volumetric energy density. To mitigate the reduction in volumetric energy density caused by this sealing section, unexamined patent application 11-67167 proposes folding the sealing section onto the upper surface of the thin type battery and laying the folded section flat against the upper surface, thereby eliminating any protruding parts. However, the thickness of the sealing section is directly added to the thickness of the battery; for thin type batteries with a thickness of 4 mm or less, this results in a minimum thickness increase of approximately 5%. As a result, the advantages associated with the use of a metal resin composite film exterior casing are compromised, and the volumetric energy density is reduced.

[0005] Furthermore, Japanese unexamined patent application 11-260327 prevents the sealing section from protruding by folding it within the thickness of the sealed type battery. However, because a single metal resin composite film is formed into a tubular shape, the film must be overlapped; consequently, the thickness of the sealed type battery increases. As a result, the volumetric energy density decreases.

[0006]

[Problems to be solved by the invention] As an improvement upon this, Japanese unexamined patent application 11-96991 proposes a structure in which the folded surface is provided with irregularities to confine the sealing section within the thickness of the sealed type battery; however, this results in a relatively complex structure. Consequently, there are problems in that the folding process is cumbersome, and it is difficult to restrain manufacturing costs. Furthermore, the strain exerted on the fold lines tends to cause cracks to form in the metal layer of the metal resin composite film,

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raising the risk that oxygen or water may subsequently penetrate into the interior of the battery.

[0007] The present invention has been made in view of the aforementioned problems, and its objective is to provide a sealed type battery that simplifies the bending process of the sealing section, enhances volumetric energy density, and eliminates the risk of cracks occurring in the metal layer of the metal resin composite film.

[0008]

[Means for resolving the problems] To achieve the aforementioned objectives, the present invention, as set forth in Claim 1, is a sealed type battery characterized as follows: a housing projection is formed in a section of a metal resin composite film comprising laminated layers of metal and resin; a power generation element, in which a positive electrode and a negative electrode are laminated via an electrolyte layer, is housed within this housing projection; a second metal resin composite film is superimposed upon the first metal resin composite film containing the housed power generation element; the inner surfaces of the superimposed pair of metal resin composite films are mutually heat-sealed together; at least a section of the resulting sealing section is bent to align along the side surface of the housing projection; and the sealing section is configured such that it does not extend beyond the top surface of the housing projection. Furthermore, regarding said sealing section, where d represents the interplanar spacing between the metal surface of the first metal resin composite film and the metal surface of the second metal resin composite film, r represents the curvature radius of the bent section of the sealing section, θ represents the bending angle of the sealing section, and a represents the elongation rate of the metal layer at the bent section as expressed by the following formula, such that the elongation rate a of the metal layer does not exceed 1.5.

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[0009]

[Formula 1]

$$a = 1 + \frac{d \cdot (\pi - \theta)}{(2r + d) \cdot (\pi - \theta) + 2d}$$

[0010] In a sealed type battery configured in this manner, the bending operation for the sealing section is simplified, as it requires merely bending the heat-sealed sealing section along the side surface of the battery's housing projection. Furthermore, since the sealing section is configured such that it does not extend beyond the top surface of the housing projection, it is prevented from protruding outward from the sealed type battery, thereby enhancing the volumetric energy density. Moreover, by setting the elongation rate a of the metal layer to a value not exceeding 1.5, the occurrence of cracks in the metal layer of the metal resin composite film during the bending of the sealing section is prevented.

[0011] Furthermore, the present invention, as set forth in Claim 2, is characterized by a section or the entirety of the bent section of the aforementioned sealing section being a non-adhered section wherein the respective metal resin composite films are not adhered, and by the extent of this non-adhered section being configured such that it does not exceed 1 mm from the boundary between the adhered section and the non-adhered section.

[0012] By incorporating an unadhered section, where the pair of metal resin composite films are not adhered to each other, within the bent section of the sealing section, the metal resin composite films in this unadhered section can shift relative to one another when the sealing section is bent, thereby alleviating strain on the films. Conversely, while including such an unadhered section in the bent section does serve to mitigate strain on the metal resin composite films, if the extent of this unadhered section becomes too large, it becomes impossible to secure a sufficient adhered section area, making the structure more susceptible to the permeation of oxygen and water. For this reason, the unadhered section within the bent section was defined to lie within 1 mm of the boundary between the adhered and unadhered sections.

[0013]

[Embodiments of the invention] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings. As shown in FIG. 1, a sealed type battery 10, representing the first embodiment of the present invention, is configured such that a housing projection 16 is formed in one of a pair of metal resin composite films 12 and 14, each of which comprises laminated metal layers 12A, 14A and resin layers 12B, 14B (see FIG. 2). A power generation element 24, in which a positive electrode and a negative electrode are laminated via an electrolyte layer, is housed within this housing projection 16. The other metal resin composite film 14 is superimposed upon the one metal resin composite film 12 containing the power generation element 24; the inner surfaces of the superimposed pair of metal resin composite films 12 and 14 are mutually fusion-sealed; and, at least a section of the resulting sealing section 26 is bent to align with side surface 17 of the housing projection 16, such that the sealing section 26 is positioned so as not to extend beyond the top surface 18 of the housing projection 16.

[0014] By bending the fusion-sealed sealing section 26 along side surface 17 of the housing projection 16, the bending operation can be performed easily and without requiring significant effort. Consequently, manufacturing costs can be restrained. Furthermore, since the bent sealing section 26 is configured not to extend beyond the top surface 18 of the housing projection 16, the sealing section 26 is prevented from protruding outward from the sealed type battery 10, thereby enhancing the volumetric energy density.

[0015] Furthermore, as shown in FIG. 2, the sealed type battery 10 is configured such that the interplanar spacing between the metal layer surface 12A of one metal resin composite film 12 and the metal layer surface 14A of the other metal resin composite film 14 is denoted as d^* , the curvature radius of the bent section 27 of the sealing section 26 as r^* , and the bending angle of the sealing section 26 as θ^* (rad). And expressing the elongation rate a^* of the metal layers (specifically,

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metal layers 12A and 14A) at the bent section 27 by the following Formula (1), the configuration is such that the elongation rate *a* of the metal layers does not exceed 1.5.

[0016]

[Formula 1]

$$a = 1 + \frac{d \cdot (\pi - \theta)}{(2r + d) \cdot (\pi - \theta) + 2d}$$

[0017] Since the elongation rate *a* of the metal layers 12A and 14A is set not to exceed 1.5, the occurrence of cracks in the metal layers 12A and 14A of the metal resin composite films 12 and 14 can be prevented when the sealing section 26 is bent.

[0018] In the sealing section 26, a part or the entirety of the bent section 27 is unattached section S1, where the respective metal resin composite films 12 and 14 are not attached together, and the extent of this unattached section S1 is configured such that it does not exceed 1 mm from the boundary 28 between the attached section S2 and the unattached section S1.

[0019] By incorporating an unattached section S1, in which the pair of metal resin composite films 12 and 14 are not adhered to each other, within the bent section 27 of the sealing section 26, the metal resin composite films 12 and 14 in the unattached section S1 are able to shift when the sealing section 26 is bent, thereby alleviating strain on the metal resin composite films 12 and 14. Consequently, the formation of cracks in the metal layers 12A and 14A of the metal resin composite films 12 and 14 can be prevented.

[0020] Conversely, while incorporating an unattached section S1 into the bent section 27 can alleviate strain in the metal resin composite films 12 and 14, if the extent of the unattached section S1 becomes too large, it becomes impossible to secure a sufficient area for the attached section S2, thereby increasing the susceptibility to the permeation of oxygen and water. For this reason, the unattached section S1 within the bent section 27 was set to lie within 1 mm from the boundary 28 between the attached section S2 and the unattached section S1.

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[0021] Next, the process for manufacturing the sealed type battery 10 will be described. First, for the positive electrode, a strip-like body is prepared in which a positive electrode active material is coated onto a 20- μ m-thick aluminum foil; for the negative electrode, a strip-like body is prepared in which a negative electrode active material is coated onto a 12- μ m-thick copper foil. Next, a positive electrode terminal 20 and a negative electrode terminal 22 are connected to these respective positive and negative electrode strips; the strips are then wound in a flat spiral configuration while stacked together, thereby yielding a power generation element (wound electrode group) 24 in which the outermost layer consists of the copper foil. A thermoplastic resin is applied to ensure that the positive electrode, the negative electrode, and the metal resin composite films 12 and 14 do not short-circuit with one another.

[0022] For the metal resin composite films 12 and 14, a material with a total thickness of 105 μ m was used, comprising 25- μ m-thick nylon layers serving as the outer-side resin layers (nylon layers) 12B, 14B; 50- μ m-thick aluminum metal foil serving as the metal layers (metal foil) 12A, 14A; and a 30- μ m-thick modified polypropylene layer serving as the adhesive layer 35 (see FIG. 2). Furthermore, a metal resin composite film in which an additional 6- μ m-thick polyethylene terephthalate layer is provided on the surface of the nylon layer may also be used to enhance solvent resistance.

[0023] Next, housing projection 16 for accommodating a power generation element 24 is formed in one of the metal resin composite films 12. Note that the housing projection 16 is a rectangle measuring 29 mm in length and 30 mm in width, formed through a deep-drawing process to a depth of 2.8 mm. After housing the power generation element 24 within the housing projection 16, the second metal resin composite film 14 is superimposed upon the first metal resin composite film 12.

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Next, the terminal section and one of the side surfaces of the pair of metal resin composite films 12 and 14 are sealed, and electrolyte is injected through the remaining unsealed surface. Following the injection, the injection port (i.e., the remaining surface) is sealed. The sealing section 26 has a width of 2.5 mm; this sealing section 26 is folded from the base of the housing projection 16 and pressed firmly against side surface 17 of the housing projection 16 to complete the manufacture of the sealed type battery 10.

[0024] Working examples

Next, the volumetric energy density of the sealed type battery 10 will be explained based on Table 1.

Note that the vertical dimension L, horizontal dimension W, and thickness dimension t shown in Table 1 correspond to those illustrated in FIGS. 1, 3, and 4.

[0025]

[Table 1]

	Vertical L (mm)	Horizontal W (mm)	Thickness t (mm)	Volumetric energy density
Working example 1	37	31	2.9	222
Comparative example 1	37	35	2.9	197
Comparative example 2	37	31	3.1	207

[0026] (Working example 1) Working example 1 illustrates a sealed type battery 10 according to the first embodiment. The sealed type battery 10 had a capacity of 200 mAh, an energy content of 740 mWh, and, excluding the positive and negative terminals 20 and 22, a volumetric energy density of 222 Wh/L.

[0027] (Comparative example 1) FIG. 3 illustrates the sealed type battery 40 of comparative example 1. The sealed type battery 40 is a battery in which the sealing portion 41 is not bent but is instead allowed to protrude directly from the housing projection 16, thereby increasing the width W. In FIG. 3, components that are identical or similar to those in the first embodiment are designated by the same reference numerals, so their descriptions are omitted. In comparative example 1, the volumetric energy density, excluding the positive and negative terminals 20 and 22, was 197 Wh/L.

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[0028] (Comparative example 2) The sealed type battery 45 of comparative example 2 is shown in FIG. 4. In the sealed type battery 45, the width of the sealing section 46 was set to 4 mm; the sealing section 46 was bent from the base of the housing projection 16 and pressed into close contact with the top surface 18 of the housing projection 16; and the thickness t was increased by an amount corresponding to the combined thickness of the metal resin composite films 12 and 14. Note that in FIG. 4, components identical or similar to those in the first embodiment are denoted by the same reference numerals, and their descriptions are omitted. The volumetric energy density of comparative example 2, excluding the positive and negative terminals 20 and 22, was 207 Wh/L.

[0029] As can be seen from Table 1, working example 1 exhibits a volumetric energy density that is approximately 10% higher than that of comparative examples 1 and 2. In other words, when housing a sealed type battery, which utilizes metal resin composite films 12 and 14 for its exterior casing, within a rectangular enclosure, it becomes evident that allowing the sealing sections 41 and 46 to protrude, as in comparative examples 1 and 2, results in a significant reduction in volumetric energy density. Conversely, it is demonstrated that by eliminating the projections of the sealing section 26, as in working example 1, a substantial improvement in volumetric energy density can be achieved.

[0030] Next, cracks occurring in the bent section 27 of the sealed type battery 10 will be described with reference to Table 2. Note that the bending angle θ , curvature radius r, and interplanar spacing d in Table 2 are illustrated in FIG. 2, and the values for the predicted elongation rate a are based on Formula 1.

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[0031]

Table 2

	Bending angle θ (rad)	Curvature radius r (mm)	Interplanar spacing d (mm)	Predicted elongation rate a	Number of bends until cracks occur
Working example 2	0	0.025	0.06	1.40	14
Working example 3	0	0.130	0.06	1.16	22
Working example 4	0	0.025	0.06	-	60
Working example 5	$\pi/2$	0.025	0.21	1.15	3
Working example 6	0	0.130	0.21	1.35	3
Working example 7	0	0.025	0.21	-	55
Comparative example 3	0	0.025	0.21	1.53	1

[0032] To investigate the degree of damage sustained by the metal resin composite films 12 and 14 due to bending, bending tests were conducted on the attached sections while the films 12 and 14 remained in their attached state. In working examples 4 and 7, the attached sections were designed to include a 0.3 mm unattached layer S1, as illustrated in FIG. 2. Other working examples 2–3 and 5–6, and comparative example 3, were designed to exclude the unattached layer S1. The attached sections of each sample were subjected to bending under the conditions specified in Table 2, and this procedure was repeated until cracks appeared in the metal layer within the bent section, while visually monitoring for such cracks.

[0033] In working examples 5, 6, and 7, and comparative example 3, a 150 μm layer of modified polypropylene was interposed within the attached section, and the sealing section was attached via heat fusion; consequently, interplanar spacing d between the metal of the laminated metal resin composite film and the opposing metal of the bonded metal resin composite film was set to 210 μm .

[0034] Regarding the results of the bending tests, as shown in Table 2, in working examples 2 to 7, when the predicted elongation rate a of the metal layers 12A and 14A of the metal resin composite films 12 and 14 is 1.5 or less, it is evident that cracks are unlikely to form in the metal layers 12A and 14A. As shown in comparative example 3, it is evident that if the predicted elongation rate a of the metal layers 12A and 14A within the metal resin composite films 12 and 14 exceeds 1.5, cracks are prone to forming in the metal layers 12A and 14A.

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Furthermore, as demonstrated in working examples 4 and 7, the inclusion of an unattached layer S1 serves to alleviate the strain applied to the metal resin composite films 12 and 14, thereby making them less susceptible to cracking.

[0035] It should be noted that the present invention is not limited to the aforementioned embodiment; rather, appropriate modifications and improvements may be made thereto. Furthermore, the materials, shapes, dimensions, forms, quantities, placement locations, thicknesses, and other attributes of the power generation elements, metal resin composite films, sealing sections, housing projections, and similar materials presented in the aforementioned embodiment may be selected arbitrarily, and are not limited, provided that they enable the realization of the present invention.

[0036]

[Effects of the invention] As described above, according to the present invention, as set forth in Claim 1, it is merely necessary to bend the fusion-sealed sealing section along the side surface of the housing projection of the sealed type battery. Consequently, the bending operation can be performed simply and without undue effort, thereby enabling a reduction in manufacturing costs. Furthermore, since the design ensures that the bent sealing section does not extend beyond the top surface of the housing projection, it prevents the sealing portion from protruding outward from the sealed type battery, thereby enhancing the volumetric energy density. Moreover, because the elongation rate a of the metal layer is configured not to exceed 1.5, the occurrence of cracks in the metal layer of the metal resin composite film during the bending of the sealing section can be prevented.

[0037] Furthermore, according to the present invention, as set forth in Claim 2, by providing the bent section of the sealing section with an unadhered section where a pair of metal resin composite films are not adhered to each other, the metal resin composite films within this unadhered section are able to shift when the sealing section is bent, thereby alleviating strain on the metal resin composite films.

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Consequently, the formation of cracks in the metal layers of the metal resin composite films can be prevented.

[0038] Conversely, while incorporating an unattached section within the bent section can alleviate strain on the metal resin composite film, if the extent of this unattached section becomes too large, it becomes impossible to secure a sufficient adhesive layer, thereby increasing the susceptibility to oxygen and water permeation. For this reason, the unattached section within the bent section was defined to lie within 1 mm of the boundary between the attached and unattached areas. Consequently, the permeation of oxygen and water can be effectively prevented.

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[Brief description of the drawings]

[FIG. 1] A plan view and a bottom view showing a first embodiment of the present invention.

[FIG. 2] An enlarged view of a portion of FIG. 1.

[FIG. 3] A plan view and a bottom view showing comparative example 1 of the present invention.

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[FIG. 4] A plan view and a bottom view showing comparative example 2 of the present invention.

[Explanation of reference numerals]

10 Sealed type battery

12, 14 Metal resin composite films

12A, 14A Metal layers

12B, 14B Resin layers

16 Housing projection

17 Side surface of the housing projection

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18 Top surface of the housing projection

24 Power generation element

26 Sealing section

27 Bent section

28 Boundary

A Elongation rate

d Interplanar spacing

r Curvature radius

θ Bending angle

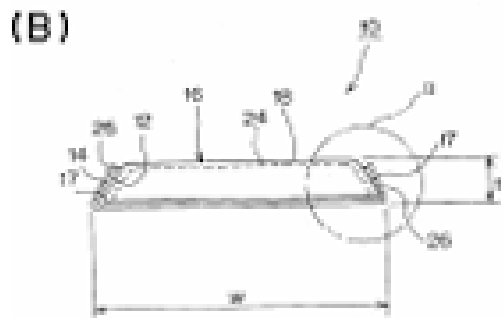
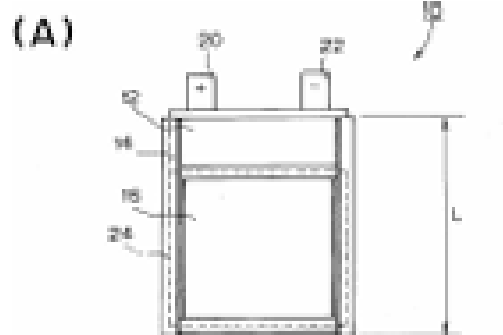
S1 Unattached section

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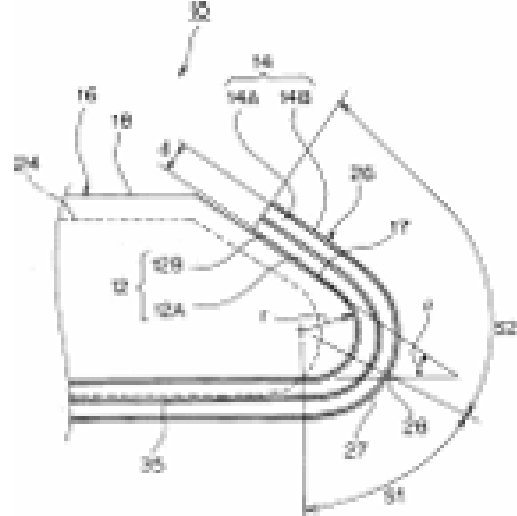
S2 Attached section

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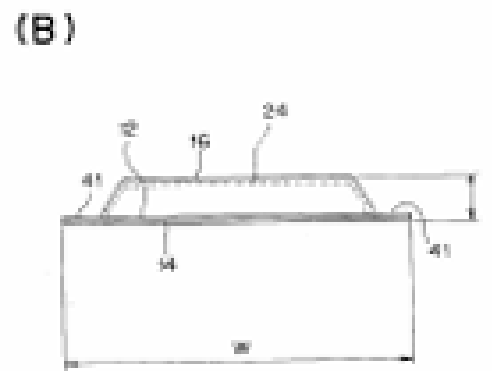
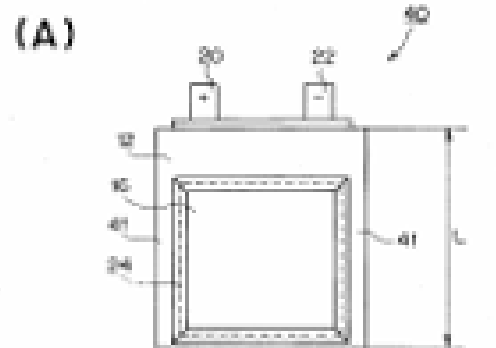
[FIG. 1]



[FIG. 2]



[FIG. 3]



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(71)出願人 000006688

株式会社ユアサコーポレーション

大阪府高槻市古曽部町二丁目3番21号

(72)発明者 新井 盛勝

大阪府高槻市古曽部町二丁目3番21号 株式

会社ユアサコーポレーション内

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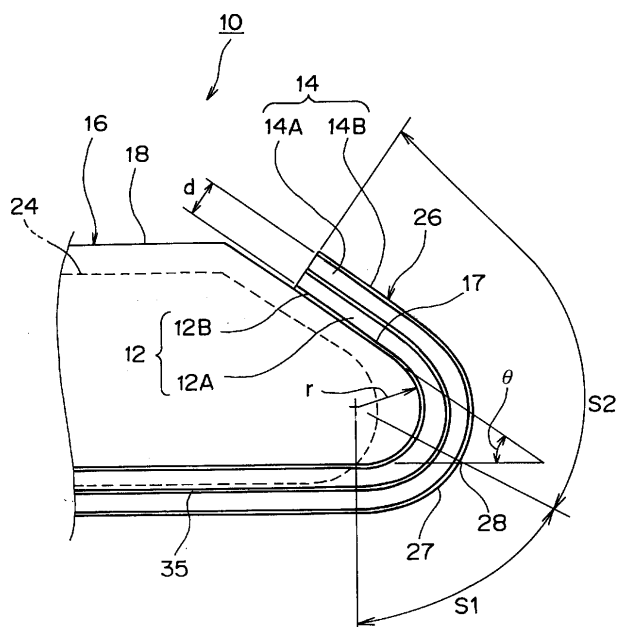
DD06 KK03

(54)【発明の名称】 密閉形電池

(57)【要約】

【課題】 封止部の曲げ作業が簡単になり、体積エネルギー密度を高め、かつ金属樹脂複合フィルムの金属層に亀裂が発生する虞れのない密閉形電池を提供する。

【解決手段】 密閉形電池10は、一方の金属樹脂複合フィルム12に収納凸部16を形成し、この収納凸部16に発電要素24を収納し、発電要素24を収納した一方の金属樹脂複合フィルム12に他方の金属樹脂複合フィルム14を重ね合わせ、重ね合わせた一对の金属樹脂複合フィルム12, 14の内面同士を互いに融着封止し、融着封止した封止部26の少なくとも一部を曲げて収納凸部16の側面17に沿わせ、この封止部26が収納凸部16の天井面18を越えないように設定し、封止部26の曲げ部27における金属層（12A, 14A）の伸び率aが1.5を越えないように設定した。



【特許請求の範囲】

【請求項1】 金属層と樹脂層とが積層された金属樹脂複合フィルムの一部に収納凸部を形成し、この収納凸部に、電解質層を介して正極および負極が積層された発電要素を収納し、発電要素を収納した一方の金属樹脂複合フィルムに他方の金属樹脂複合フィルムを重ね合わせ、重ね合わせた一対の金属樹脂複合フィルムの内面同士を互いに融着封止し、融着封止した封止部の少なくとも一部を曲げて収納凸部の側面に沿わせ、この封止部が収納凸部の天井面を越えないように設定した密閉形電池であって、
前記封止部は、一方の金属樹脂複合フィルムの金属層面と他方の金属樹脂複合フィルムの金属層面との面間隔をd、封止部の曲げ部の曲率半径をr、封止部の曲げ角度を θ とし、曲げ部における金属層の伸び率aを次式で表すと、金属層の伸び率aが1.5を越えないように設定したことを特徴とする密閉形電池。

【数1】

$$a = 1 + \frac{d \cdot (\pi - \theta)}{(2r + d) \cdot (\pi - \theta) + 2d}$$

【請求項2】 前記封止部の曲げ部の一部または全てが、各々の金属樹脂複合フィルムを接着しない未接着部とし、この未接着部の範囲が接着部と未接着部との境界から1mmを越えないような囲に設定したことを特徴とする請求項1に記載した密閉形電池。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は密閉形電池に係り、特に電池の厚さが4mm以下の密閉形電池に関する。

【0002】

【従来の技術】リチウムイオン電池は薄型で高いエネルギー密度を有することから、携帯用端末器電源に多く用いられ、更なる高容量化、薄型化が要求されている。この小型二次電池の構成としては、捲回した極群（発電要素）を円筒型のケースに収納した円筒型電池や、平板状の極板を積層した発電要素を平角型ケースに収納した角型電池がある。より安価で軽量の小型二次電池を提供する手段として、例えば実開昭60-162362号公報や特開昭61-206157号公報では、発電要素をアルミ金属樹脂複合フィルムの袋に収納し、熱融着により封口したものが提案されている。

【0003】特に、電池の厚さが4mm以下の薄型の密閉形電池においては、外装体の厚さがエネルギー密度に大きく影響する。そのため、薄型電池の外装体には、従来の金属缶に比べて厚さ寸法が $1/5 \sim 1/3$ である金属樹脂複合フィルム外装体が多く用いられる。この金属樹脂複合フィルム外装体を用いた密閉形電池は、金属樹脂複合フィルムの端部同士を重ねあわせて封止部を接着したものであり、封止部の接着剤層を透過して酸素や水が

電池内部に侵入することを防ぐため、封止部の幅をある程度大きく設定している。

【0004】このため、封止部の面積は、最低でも薄型電池の約4%程度を占め、薄型電池の体積エネルギー密度に大きく関わってきた。この封止部による体積エネルギー密度の低下を抑えるために、特開平11-67167号公報では封止部を薄型電池の上面側に折り曲げて、この折り曲げ部分を薄型電池の上面に這わすことで突出部をなくしている。しかし、封止部の厚さがそのまま電池厚さに加算され、厚さが4mm以下の薄型電池では最低でも約5%の厚さの増加となり、金属樹脂複合フィルム外装体を用いた利点が損なわれ、体積エネルギーも減少する。

【0005】また、特開平11-260327号公報では封止部を密閉形電池の厚さの範囲内で折り曲げることにより、封止部の突出を防いでいる。しかし、1枚の金属樹脂複合フィルムを筒状に形成するために、金属樹脂複合フィルムを重ね合わせるため密閉形電池の厚さが増す。このため、体積エネルギーが減少する。

【0006】

【発明が解決しようとする課題】この改良品として、特開平11-96991号公報では、折り返された面に凹凸を付けて、封止部を密閉形電池の厚さ内に抑えたものが提案されているが、構造が比較的複雑になる。このため、折込み作業が煩雑であり、製造コストを抑え難いという問題がある。加えて、折れ目にかかる歪で金属樹脂複合フィルムの金属層に亀裂が生じやすく、そこから酸素や水が電池内部に侵入するという虞れがある。

【0007】本発明は、前述した問題点を鑑みてなされたものであり、その目的は、封止部の曲げ作業が簡単になり、体積エネルギー密度を高め、かつ金属樹脂複合フィルムの金属層に亀裂が発生する虞れのない密閉形電池を提供することにある。

【0008】

【課題を解決するための手段】前述した目的を達成するために、本発明は、請求項1に記載したように、金属と樹脂が積層された金属樹脂複合フィルムの一部に収納凸部を形成し、この収納凸部に、電解質層を介して正極および負極が積層された発電要素を収納し、発電要素を収納した一方の金属樹脂複合フィルムに他方の金属樹脂複合フィルムを重ね合わせ、重ね合わせた一対の金属樹脂複合フィルムの内面同士を互いに融着封止し、融着封止した封止部の少なくとも一部を曲げて収納凸部の側面に沿わせ、この封止部が収納凸部の天井面を越えないように設定した密閉形電池であって、前記封止部は、一方の金属樹脂複合フィルムの金属面と他方の金属樹脂複合フィルムの金属面との面間隔をd、封止部の曲げ部の曲率半径をr、封止部の曲げ角度を θ とし、曲げ部における金属層の伸び率aを次式で表すと、金属層の伸び率aが1.5を越えないように設定したことを特徴としている。

【0009】

【数1】

$$a = 1 + \frac{d \cdot (\pi - \theta)}{(2r + d) \cdot (\pi - \theta) + 2d}$$

【0010】このように構成された密閉形電池においては、融着封止された封止部を密閉形電池の収納凸部の側面に沿って曲げるだけでよいので、封止部の曲げ作業が簡単になる。また、曲げた封止部が収納凸部の天井面を越えないように設定したので、封止部を密閉形電池から突出することを防ぎ、体積エネルギー密度を高める。さらに、金属層の伸び率 a が 1.5 を越えないように設定したので、封止部を曲げた際に金属樹脂複合フィルムの金属層に亀裂が発生することを防ぐ。

【0011】また、本発明においては、請求項 2 に記載したように、前記封止部の曲げ部の一部または全てが、各々の金属樹脂複合フィルムを接着しない未接着部とし、この未接着部の範囲が接着部と未接着部との境界から 1mm を越えないような範囲に設定したことを特徴とする。

【0012】封止部の曲げ部に、一対の金属樹脂複合フィルムが接着されていない未接着部を含むことで、封止部を曲げる際に、未接着部の金属樹脂複合フィルムをずらして金属樹脂複合フィルムの歪を緩和できる。一方、曲げ部に未装着部を含めれば、金属樹脂複合フィルムの歪を緩和できるが、未装着部の範囲が大きくなると接着層を十分にとれなくなり、酸素や水が透過されやすくなる。このため、曲げ部の未装着部を、接着部と未接着部との境界から 1mm 以内に設定した。

【0013】

【発明の実施の形態】以下、本発明に係る実施形態を図面に基づいて詳細に説明する。図 1 に示すように、本発明に係る第 1 実施形態である密閉形電池 10 は、金属層 12A、14A と樹脂層 12B、14B（図 2 参照）とが積層された一対の金属樹脂複合フィルム 12、14 のうちの一方に収納凸部 16 を形成し、この収納凸部 16 に、電解質層を介して正極および負極が積層された発電要素 24 を収納し、発電要素 24 を収納した一方の金属樹脂複合フィルム 12 に他方の金属樹脂複合フィルム 14 を重ね合わせ、重ね合わせた一対の金属樹脂複合フィルム 12、14 の内面同士を互いに融着封止し、融着封止した封止部 26 の少なくとも一部を曲げて収納凸部 16 の側面 17 に沿わせ、この封止部 26 が収納凸部 16 の天井面 18 を越えないように設定したものである。

【0014】融着封止された封止部 26 を収納凸部 16 の側面 17 に沿って曲げることにより、曲げ作業を手間をかけないで簡単にできる。したがって、製造コストを抑えることができる。また、曲げた封止部 26 を、収納凸部 16 の天井面 18 を越えないように設定したので、封止部 26 を密閉形電池 10 から突出することを防ぎ、体積エネルギー密

度を高める。

【0015】また、図 2 に示すように、密閉形電池 10 は、一方の金属樹脂複合フィルム 12 の金属層 12A 面と他方の金属樹脂複合フィルム 14 の金属層 14A 面との面間隔を d 、封止部 26 の曲げ部 27 の曲率半径を r 、封止部 26 の曲げ角度を θ (rad) とし、曲げ部 27 における金属層（すなわち、金属層 12A、14A）の伸び率 a を次式（1）で表すと、金属層の伸び率 a が 1.5 を越えないように設定した。

【0016】

【数1】

$$a = 1 + \frac{d \cdot (\pi - \theta)}{(2r + d) \cdot (\pi - \theta) + 2d}$$

【0017】金属層 12A、14A の伸び率 a が 1.5 を越えないように設定したので、封止部 26 を曲げた際に金属樹脂複合フィルム 12、14 の金属層 12A、14A に亀裂が発生することを防止できる。

【0018】封止部 26 は、曲げ部 27 の一部または全てが、各々の金属樹脂複合フィルム 12、14 を接着しない未接着部 S1 とし、この未接着部 S1 の範囲が接着部 S2 と未接着部 S1 との境界 28 から 1mm を越えないように範囲に設定した。

【0019】封止部 26 の曲げ部 27 に、一対の金属樹脂複合フィルム 12、14 が接着されていない未接着部 S1 を含むことで、封止部 26 を曲げた際に、未接着部 S1 の金属樹脂複合フィルム 12、14 がずれて金属樹脂複合フィルム 12、14 の歪を緩和できる。したがって、金属樹脂複合フィルム 12、14 の金属層 12A、14A に亀裂が入ることを防止できる。

【0020】一方、曲げ部 27 に未装着部 S1 を含めれば、金属樹脂複合フィルム 12、14 の歪を緩和できるが、未接着部 S1 の範囲が大きくなると接着部 S2 を十分に確保できなくなり、酸素や水が透過されやすくなる。このため、曲げ部 27 の未装着部 S1 を、接着部 S2 と未接着部 S1 との境界 28 から 1mm 以内に設定した。

【0021】次に、密閉形電池 10 を製造する工程を説明する。まず、正極用に厚さ 20 μm のアルミニウム箔上に正極活物質が塗布された帯状体を準備し、負極用に厚さ 12 μm の銅箔上に負極活物質が塗布された帯状体を準備する。次に、これらの正極、負極の帯状体にそれぞれ正極端子 20、負極端子 22 を接続し、帯状体を積層した状態で偏平渦状に捲回し、最外周が銅箔になる発電要素（捲回式極群）24 を得る。正極、負極、金属樹脂複合フィルム 12、14 が互いに短絡しないように熱可塑性樹脂を付ける。

【0022】金属樹脂複合フィルム 12、14 には、外装側の樹脂層（ナイロン層）12B、14B として厚さ 25 μm のナイロン層、金属層（金属箔）12A、14A として厚さ 50 μm のアルミニウム金属箔、接着層 35（図 2 参照）とし

て厚さ30 μ mの変性ポリプロピレン層を積層した厚さ105 μ mのものを用いた。また、耐溶剤性を向上させるためにナイロン層の表面に6 μ mのポリエチレンテレフタレート層をさらに設けた金属樹脂複合フィルムを用いてもよい。

【0023】次に、一方の金属樹脂複合フィルム12に、発電要素24を収納するための収納凸部16を形成する。なお、収納凸部16は、縦29mm、横30mmの長方形で、深さ2.8mmになるように絞り加工を施したものである。収納凸部16に発電要素24を納めた後、一方の金属樹脂複合フィルム12に他方の金属樹脂複合フィルム14を重ね合わせ、一対の金属樹脂複合フィルム12、14のうちの端子部と側*

	縦L (mm)	横W (mm)	厚さt (mm)	体積エネルギー密度(Wh/L)
実施例1	37	31	2.9	222
比較例1	37	35	2.9	197
比較例2	37	31	3.1	207

【0026】(実施例1) 実施例1は、第1実施形態の密閉形電池10を示し、密閉形電池10は、容量が200mAh、エネルギー量が740mWh、正負の端子20、22を含まない体積エネルギー密度が222Wh/Lであった。

【0027】(比較例1) 比較例1の密閉形電池40を図3に示す。密閉形電池40は、封止部41を曲げないで、そのまま収納凸部16から突出させ、幅Wを大きくした電池である。なお、図3において、第1実施形態と同一類似部材については同一符号を付して説明を省略する。比較例1は、正負の端子20、22を含まない体積エネルギー密度が197Wh/Lであった。

【0028】(比較例2) 比較例2の密閉形電池45を図4に示す。密閉形電池45は、封止部46の幅を4mmにし、封止部46を収納凸部16の元から曲げて、収納凸部16の天井面18まで密着させ、厚さtを金属樹脂複合フィルム12、14分厚くした電池である。なお、図4において、第1実施形態と同一類似部材については同一符号を付して*

	曲げ角度 θ (rad)	曲率半径r (mm)	面間隔d (mm)	予想伸び率a	亀裂が生じるまでの曲げ回数
実施例2	0	0.025	0.06	1.40	14
実施例3	0	0.130	0.06	1.16	22
実施例4	0	0.025	0.06	—	60
実施例5	$\pi/2$	0.025	0.21	1.15	3
実施例6	0	0.130	0.21	1.35	3
実施例7	0	0.025	0.21	—	55
比較例3	0	0.025	0.21	1.53	1

【0032】曲げによる金属樹脂複合フィルム12、14の損傷の度合いを調べるために、金属樹脂複合フィルム12、14を接着させた状態で、接着部の曲げ試験を行った。実施例4および実施例7は、接着部に図2に示す未接着層S1を0.3mm含ませ、それ以外の実施例2～3、実施例5～6および比較例3は未接着層S1を含まないようにした。それぞれの試料の接着部を、表2に示す曲げ条件で曲げ、曲げ部分の金属層の亀裂を目視で確認しな

*面的一方を塞ぎ、残りの一方から電解液を注液する。注液後、注液口(すなわち、残りの一方)を封口する。封止部26は幅が2.5mmであり、この封止部26を収納凸部16の元から折り曲げ、収納凸部16の側面17に密着させて、密閉形電池10を製造する。

【0024】実施例

次に、密閉形電池10の体積エネルギー密度について表1に基づいて説明する。なお、表1の縦寸法L、横寸法W、厚さ寸法tは、図1、図3～図4に示す。

【0025】

【表1】

*説明を省略する。比較例2は、正負の端子20、22を含まない体積エネルギー密度が207Wh/Lであった。

【0029】表1から実施例1は比較例1、2に比べて、体積エネルギー密度が一割程度増加していることが判る。すなわち、外装体に金属樹脂複合フィルム12、14を用いた密閉形電池を直方体に収納する場合、比較例1、2のように封止部41、46を突出させると体積エネルギー密度をかなり損なわせることが判る。そして、実施例1のように封止部26の突出部をなくすことにより、かなりの体積エネルギー密度を向上させることができることが判る。

【0030】次いで、密閉形電池10の曲げ部27に発生する亀裂について表2に基づいて説明する。なお、表2の曲げ角度 θ 、曲率半径r、面間隔dは図2に示し、予想伸び率aの値は数1に基づく。

【0031】

【表2】

がら、亀裂が生じるまで同様の操作を繰り返した。

【0033】なお、実施例5、6、7および比較例3は接着部に150 μ mの変性ポリプロピレンを挟んで、熱融着により封止部を接着し、金属樹脂複合フィルムの積層された金属と対面の接着された金属樹脂複合フィルムの金属との面間隔dを210 μ mにした。

【0034】曲げ試験の結果は表2に示すように、実施例2～7のように金属樹脂複合フィルム12、14の金属層

12A, 14Aの予想伸び率 a が1.5以下の場合、金属層12A, 14Aに亀裂が入り難く、比較例3のように金属樹脂複合フィルム12, 14の金属層12A, 14Aの予想伸び率 a が1.5よりも大きいと、金属層12A, 14Aに亀裂が入り易いことが判る。また、実施例4および実施例7のように未接着層S1を含ませると金属樹脂複合フィルム12, 14にかかる歪が緩和され、亀裂が入りにくいことが判る。

【0035】なお、本発明は、前述した各実施形態に限定されるものでなく、適宜な変形、改良等が可能であり、前述した各実施形態において例示した発電要素、金属樹脂複合フィルム、封止部、収納凸部等の材質、形状、寸法、形態、数、配置個所、厚さ寸法等は本発明を達成できるものであれば任意であり、限定されない。

【0036】

【発明の効果】以上、説明したように、本発明によれば、請求項1に記載したように、融着封止された封止部を密閉形電池の収納凸部の側面に沿って曲げるだけでよい。このため、曲げ作業を手間をかけないで簡単にできるので、製造コストを抑えることができる。また、曲げた封止部が収納凸部の天井面を越えないように設定したので、封止部を密閉形電池から突出することを防ぎ、体積エネルギー密度を高める。さらに、金属層の伸び率 a が1.5を越えないように設定したので、封止部を曲げた際に金属樹脂複合フィルムの金属層に亀裂が発生することを防止できる。

【0037】また、本発明によれば、請求項2に記載したように、封止部の曲げ部に、一対の金属樹脂複合フィルムが接着されていない未接着部を含むことで、封止部を曲げた際に、未接着部の金属樹脂複合フィルムがずれ

【0038】一方、曲げ部に未装着部を含めれば、金属樹脂複合フィルムの歪を緩和できるが、未接着部の範囲が大きくなると接着層を十分にとれなくなり、酸素や水が透過されやすくなる。このため、曲げ部の未装着部を、接着部と未接着部との境界から1mm以内に設定した。よって、酸素や水の透過を十分に防止できる。

【図面の簡単な説明】

【図1】本発明に係る第1実施形態を示す平面図および底面図である。

【図2】図1の2部拡大図である。

【図3】本発明に係る比較例1を示す平面図および底面図である。

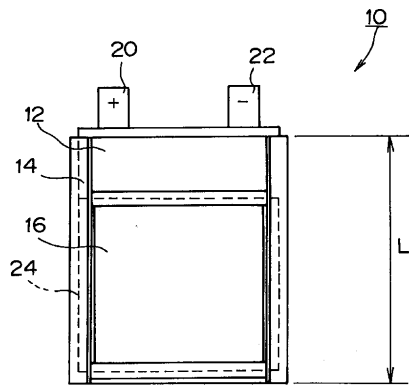
【図4】本発明に係る比較例2を示す平面図および底面図である。

【符号の説明】

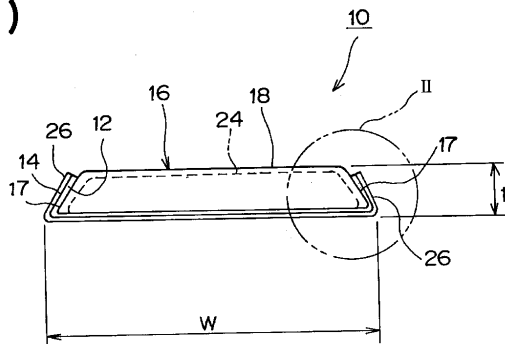
- 10 密閉形電池
- 12, 14 金属樹脂複合フィルム
- 12A, 14A 金属層
- 12B, 14B 樹脂層
- 16 収納凸部
- 17 収納凸部の側面
- 18 収納凸部の天井面
- 24 発電要素
- 26 封止部
- 27 曲げ部
- 28 境界
- A 伸び率
- d 面間隔
- r 曲率半径
- θ 曲げ角度
- S1 未接着部
- S2 接着部

【図 1】

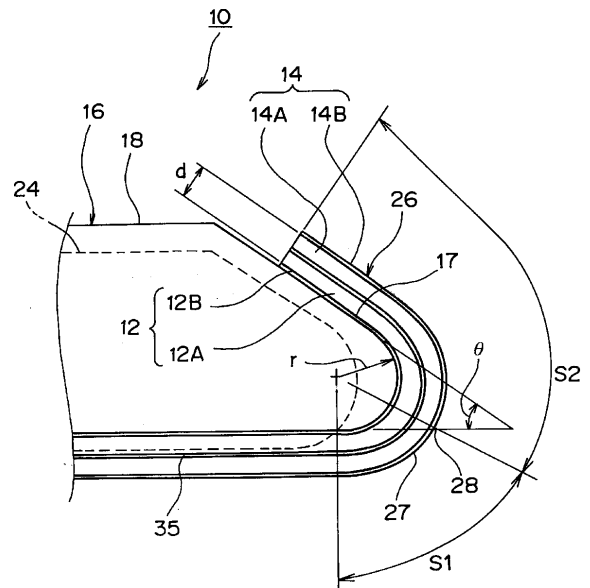
(A)



(B)

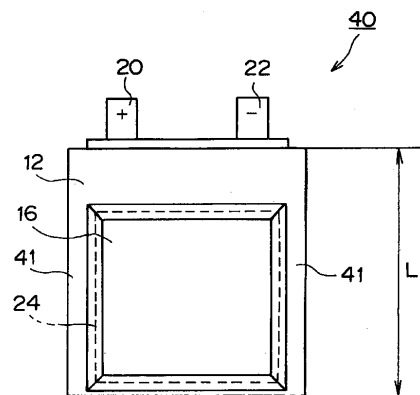


【図 2】

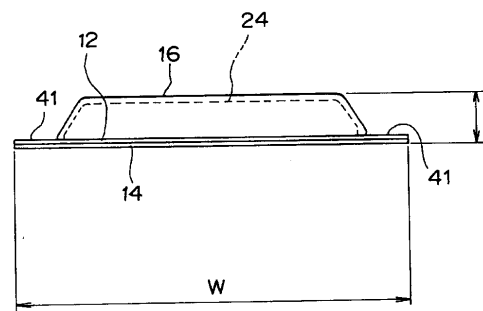


【図 3】

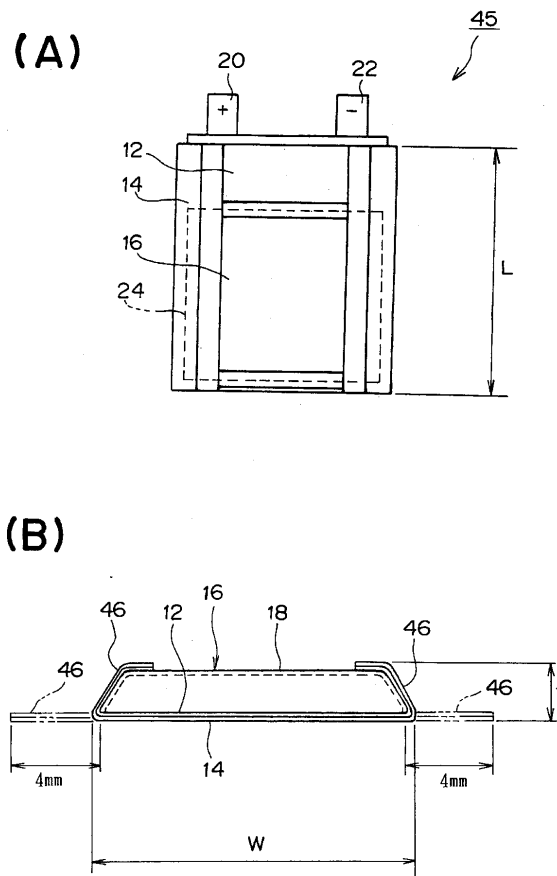
(A)



(B)



【図4】



TRANSLATION CERTIFICATION

Date: May 7, 2026

To whom it may concern:

I, Daniel McDonald, a translator fluent in the Japanese and English languages, on behalf of Morningside, do solemnly and sincerely declare that the following is, to the best of my knowledge and belief, a true and correct translation of the document(s) listed below in a form that best reflects the intention and meaning of the original text.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

The document is designated as:

- JP2002025512A (Arai)

DM

Signature

Daniel McDonald

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