Description

Button cells and method for producing same

[0001] The present invention relates to button cells comprising two metallic housing half-parts, which are separated from one another by an electrically insulating seal and which form a housing with a flat bottom area and a flat top area parallel to it, as well as within the housing, an electrode-separator assembly comprising at least one positive and at least one negative electrode, which are in the form of flat layers and are connected to one another by at least one flat separator, and to a method for producing such button cells.

[0002] Button cells normally have a housing consisting of two housing half-parts, a cell cup and a cell top. By way of example, these may be produced from nickel-plated deep-drawn metal sheet as stamped and drawn parts. The cell cup normally has positive polarity, and the housing top negative polarity. The housing may contain widely differing electrochemical systems, for example zinc/MnO_2, primary and secondary lithium systems, or secondary systems such as nickel/cadmium or nickel/metal hydride.

[0003] By way of example, rechargeable button cells based on nickel/metal hydride or lithium-ion systems are in widespread use. In the case of lithium-ion button cells, the electrochemically active materials are normally not arranged within the button cell housing in the form of individual electrodes, in the form of tablets, separated from one another by a separator. Instead of this, prefabricated electrode-separator assemblies are preferably inserted flat into the housing. In this case, a porous plastic film is preferably used as a separator, onto which the electrodes are laminated or adhesively bonded flat. The entire assembly comprising the separator and the electrodes in this case generally has a maximum thickness of a few hundred

µm. In order to allow button cell housings of normal dimensions to be filled, a plurality of such assemblies are therefore frequently placed flat one on top of the other. This allows stacks of any desired height, in principle, to be produced, in each case matched to the available dimensions of the button cell housing into which the stack is intended to be installed. This ensures optimum utilization of the available area within the housing.

[0004] By virtue of the design, however, various problems also occur in the case of button cells which contain such stacks of electrode-separator assemblies. On the one hand, it is necessary, of course, for the electrodes of the same polarity each to be connected to one another within the stack, and then each to make contact with the corresponding pole of the button cell housing. The required electrical contacts result in material costs, and the space occupied by them is, furthermore, no longer available for active material. In addition, the production of the electrode stacks is complicated and expensive since faults can easily occur when the assemblies make contact with one another, increasing the scrap rate. On the other hand, it has been found that button cells having a stack of electrodes and separators very quickly start to leak.

[0005] Traditionally, button cells have been closed in a liquid-tight manner by beading the edge of the cell cup over the edge of the cell top in conjunction with a plastic ring, which is arranged between the cell cup and the cell top and at the same time acts as a sealing element and for electrical insulation of the cell cup and of the cell top. Button cells such as these are described, for example, in DE 31 13 309.

[0006] However, alternatively, it is also possible to manufacture button cells in which the cell cup and the cell top are held together in the axial direction exclusively by a force-fitting connection, and which do not have a beaded-over cup edge. Button cells such as these and methods for their production are described in the still unpublished German patent application

with the file reference 10 2009 017 514.8. Irrespective of the various advantages which button cells such as these without beading may have, they can, however, not be loaded as heavily in the axial direction as comparable button cells with a beaded-over cup edge, in particular with respect to axial mechanical loads which are caused in the interior of the button cell. For example, the electrodes of rechargeable lithium-ion systems are continually subject to volume changes during charging and discharging processes. The axial forces which occur in this case can, of course, lead to leaks more readily in the case of button cells without beading than in the case of button cells with beading.

[0007] The present invention was based on the object of providing a button cell in which the problems mentioned above do not occur, or occur only to a greatly reduced extent. In particular, the button cell is intended to be more resistant to mechanical loads which occur in the axial direction than conventional button cells, in particular even when they are manufactured as button cells without a beaded-over cup edge.

[0008] This object is achieved by the button cell having the features of claim 1. Preferred embodiments of the button cell according to the invention are defined in the dependent claims 2 to 10. The method according to claim 11 also contributes to the solution of the problem according to the invention. Preferred embodiments of the method according to the invention are defined in dependent claims 12 to 14. The wording of all the claims is hereby included by reference to the content of this description.

[0009] A button cell according to the invention always comprises two metallic housing half-parts, which are separated from one another by an electrically insulating seal and form a housing with a flat bottom area and a flat top area parallel to it. As already mentioned initially, the two housing half-parts are generally a so-called housing cup and a housing top. In particular, parts

composed of nickel-plated steel or metal sheet are preferred as housing half-parts. Furthermore, trimetals, for example with the sequence of nickel, steel (or stainless steel) and copper (with the nickel layer preferably forming the outer layer and the copper layer preferably forming the inside of the button cell housing) are particularly suitable for use as the metallic material.

[0010] By way of example, an injection-molded or film seal can be used as a seal. The latter are described, for example, in DE 196 47 593.

[0011] Within the housing, a button cell according to the invention comprises an electric-separator assembly with at least one positive and at least one negative electrode. These are each in the form of flat electrode layers. The electrodes are connected to one another via a flat separator. The electrodes are preferably laminated or adhesively bonded onto this separator. The electrodes and the separator generally each have thicknesses only in the µm range. In general, a porous plastic film is used as the separator.

[0012] In contrast to the button cells mentioned initially, the button cell according to the invention is distinguished in particular by the electrode layers having a very particular orientation, specifically being aligned essentially at right angles to the flat bottom and top areas. While button cells known from the prior art with stacked electrode-separator assemblies always contain these assemblies inserted flat, such that the electrode layers are aligned essentially parallel to the flat bottom and top areas, the situation in a button cell according to the invention is the opposite of this.

[0013] The right-angled alignment of the electrode layers has an unexpectedly considerable advantage, specifically because it has been found that this alignment results in a considerable improvement in the sealing characteristics of a button cell according to the invention, particularly for button cells based on lithium-ion systems. The electrodes of rechargeable lithium-ion

systems are continually subject to volume changes during charging and discharging processes. Volume changes such as these also occur, of course, in the electrodes of a button cell according to the invention. However, the mechanical forces which are created during this process no longer act primarily axially, as in the case of a stack of electrode-separator assemblies which are inserted flat. Because of the right-angled alignment of the electrodes, they in fact act radially. Radial forces can be absorbed very much better than axial forces by the housing of a button cell. The improved sealing characteristics are presumably a result of this.

[0014] Particularly preferably, the electrodes and the flat separator of a button cell according to the invention are each in the form of strips or ribbons. By way of example, the production of a button cell according to the invention can be based on a separator material in the form of an endless ribbon, onto which the electrodes are applied, in particular laminated, once again in particular in the form of strips or at least rectangles.

[0015] In the housing of a button cell according to the invention, this assembly is particularly preferably in the form of a winding, in particular in the form of a spiral winding. Windings such as these can be produced very easily using known methods (see for example DE 36 38 793), by applying the electrodes flat, in particular in the form of strips, to a separator which is in the form of an endless ribbon, in particular by laminating them on. In this case, the assembly comprising electrodes and separators is generally wound onto a so-called winding mandrel. Once the winding has been removed from the winding mandrel an axial cavity remains in the center of the winding. This allows the winding to expand into this cavity, if necessary. However, in some circumstances, this can lead to problems in making electrical contact between the electrodes and the metallic housing half-parts, and this will be described in more detail in the following text.

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