

A BATTERY CELL DISMANTLING SYSTEM

[0001] The present application relates to a battery cell dismantling system, and to a method for dismantling a battery cell.

Background

[0002] A lithium-ion battery is a common type of rechargeable battery that uses the reversible intercalation of positively charged lithium ions to store energy. These types of batteries are used in many electrical products such as electric toys, wireless headphones, handheld power tools, electric vehicles, and electrical energy storage systems and more. Due to the improved environmental sustainability of electrical energy over other forms of energy such as coal, oil and gas, and the increased performance of sustainable energy generation technologies, the demand for products that are powered by lithium-ion batteries is constantly increasing.

[0003] A lithium-ion battery pack, module, or system may be made up of one or more battery cells. A basic illustration of a lithium ion-battery cell 100 is illustrated in figure 1. The cell 100 in figure 1 is shown as partially deconstructed for the purpose of illustration. The cell 100 comprises an outer casing 102 that surrounds, and protects, a lithium core 104. The lithium core 104 comprises three internal components: a first electrode 106, a second electrode 108 and a separator 110. The first and second electrodes 106, 108 are conductors through which electric energy is able to enter and leave the cell. The first electrode 106 may act as a cathode (i.e., a positive electrode) and a second electrode 108 may act as an anode (i.e., a negative electrode), or vice versa depending on the flow of electrical energy through the battery cell 100. The separator 110 is a porous foil such as a polymeric foil. More specifically, the separator 110 is porous to lithium ions such that lithium ions can move between the first and second electrodes through the separator. The three internal components of the battery cell 100 may be rolled together inside the outer casing 102 of the battery cell as illustrated in figure 1. In alternative configurations, the internal components may be stacked together. The cell 100 has a first end 112, a second end 114 and a length 116 that extends between its first and second ends. The cell 100 further comprises a terminal 118 located at each of its first and second ends. The terminals 118 enable the transfer of electrical energy to and from an external device.

[0004] The lithium core 104 of the battery cell 100 is filled with an electrolyte, which is a liquid, gel or powder that conducts electricity. During manufacturing of the battery cell, the electrolyte may be filled into the casing 102 either before or after the electrode and separator layers are inserted. The electrolyte may coat the first and second electrodes 104, 106. The electrolyte is more specifically a carrier for lithium ions. A lithium salt may be mixed into the electrolyte to increase its lithium concentration. The electrolyte that is used in lithium-ion cells is often an organic compound such as dimethyl carbonate (DMC), diethyl carbonate (DEC), ethyl methyl

carbonate (EMC), propylene carbonate (PC) or ethylene carbonate (EC), although other electrolyte materials may alternatively be used.

[0005] The materials of the electrodes, separator and electrolyte contained within the core 104 of a lithium-ion battery cell are suitable for recycling, which means that these types of cells are nominally environmentally sustainable. However, in order for the inner materials of the cell to be reused they must be extracted from the outer casing 102 and separated so that each material can be independently recycled. Without an effective method for extracting the materials out of lithium-ion batteries, the batteries are likely to end up in landfill, negating their potential impact on sustainability, hindering the environmental benefits that electric power offers.

[0006] There is a desire for a system and method that is able to extract the inner materials from a lithium-ion battery cell so that those materials can be recycled.

Summary

[0007] The invention is defined by the claims. This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to determine the scope of the claimed subject matter; variants and alternative features which facilitate the working of the invention and/or serve to achieve a substantially similar technical effect should be considered as falling into the scope of the invention disclosed herein.

[0008] There is disclosed in the following a battery cell dismantling system comprising: a battery carrier, configured to house a battery; a transportation means configured to carry the battery carrier through the system in a first direction; a first cutting station comprising first and second cutting tools, the first cutting tool being located on a first side of the transportation means and the second cutting tool being located on a second side of the transportation means, each of the first and second cutting tools being configured to apply a cutting force in a second direction that opposes the first direction; and an extraction station comprising: a pressing means that is moveable in a third direction on the first side of the transportation means and configured to apply a pressing force to a first side of the battery cell, wherein the third direction is perpendicular to the first direction; and an extraction means located on a second side of the transportation means and being configured to extract material from a second side of the battery cell.

[0009] The system may further comprise a second cutting station comprising a third cutting tool, the third cutting tool being configured to apply a cutting force in the third direction.

[0010] The battery carrier may comprise one or more channels extending therethrough, each channel being configured to house a battery.

[0011] Each channel of the one or more channels may be a cylindrical channel that extends from a first end of the battery carrier to a second end of the battery carrier.

[0012] The battery carrier may further comprise a slot extending from a third end of the battery carrier and intersecting with the channel.

[0013] The system may further comprise a plurality of battery carriers, wherein the system is configured to accommodate a different battery carrier at each of the first cutting station, the second cutting station and the extraction station at the same time.

[0014] The transportation means may be a single conveyor belt.

[0015] The transportation means may comprise a plurality of conveyor belts that are arranged along the length of the transportation means.

[0016] The transportation means may further comprise a plurality of raisable platforms, each raisable platform being moveable above the plurality of conveyor belts.

[0017] The first and second cutting tools may be fixedly mounted relative to the transportation means.

[0018] The first and second cutting tools may be moveable relative to the transportation means.

[0019] The first and second cutting tools may be cutting tools that are rotatable about an axis that extends perpendicularly to the first direction.

[0020] The second cutting station may be movable relative to the transportation means.

[0021] The second cutting station may be mounted to a linear slide unit.

[0022] The cutting tools of the second cutting station may be circular saws.

[0023] The second cutting station may comprise a plurality of cutting tools, and the number of cutting tools in the second cutting station may be the same as the number of channels in the battery carrier.

[0024] The number of channels in the battery carrier may be 10, 20 or 40 channels.

[0025] The extraction station may be coupled to a linkage so that it is movable relative to the transport system.

[0026] The extraction means may be a pin that extends from a first end that faces the transportation means to a second end.

[0027] The extraction means may comprise a collecting container at its second end.

[0028] The transportation means may be a first transportation means and the system may further comprise a second transportation means that is located below the first transportation means.

[0029] The system may further comprise a programmable logic controller configured to monitor and individually control processes of one or more of the transportation means, the first cutting station and the pressing means.

[0030] The geometry of the battery carrier may be adaptable.

[0031] There is also provided a method for dismantling a battery comprising: housing the battery in a battery carrier; carrying the battery carrier through the system in a first direction; cutting a first end and a second end of the battery in a second direction that opposes the first direction; and applying a pressing force to the first end of the battery in a third direction that is perpendicular to the first direction whilst extracting material from a second side of the battery.

[0032] The method may further comprise cutting the first end of the battery in the third direction.

[0033] The preferred features may be combined as appropriate, as would be apparent to a skilled person, and may be combined with any of the aspects of the invention.

Brief description of the drawings

[0034] Examples of the invention will be described, by way of example, with reference to the following drawings, in which:

[0035] Figure 1 is an illustration of a lithium-ion battery;

[0036] Figure 2 illustrates a first example of a battery cell dismantling system;

[0037] Figure 3 illustrates a second example of a battery cell dismantling system;

[0038] Figure 4 illustrates an enlarged version of an example of a first cutting station;

[0039] Figure 5 illustrates an enlarged version of an example of a second cutting station;

[0040] Figure 6 illustrates an enlarged version of an example of an extraction station;

[0041] Figure 7 illustrates a first example of a battery carrier;

[0042] Figure 8 illustrates a second example of a battery carrier;

[0043] Figure 9 illustrates a further component of the battery carrier of figures 7 and 8;

[0044] Figure 10 illustrates an assembled battery carrier;

[0045] Figure 11 illustrates a method of dismantling a battery.

Detailed description

[0046] Examples of the present invention are described below by way of example only. These examples represent the best mode of putting the invention into practice that are currently known to the Applicant although they are not the only ways in which this could be achieved. The description sets forth the functions of the example and the sequence of steps for constructing and operating the example. However, the same or equivalent functions and sequences may be accomplished by different examples.

[0047] Figures 2 and 3 show different illustrations of a battery cell dismantling system. Figure 2 illustrates a first system 200 and figure 3 illustrates a second system 300. The system 200, 300 may alternatively be described as a processing pipeline, or a machining pipeline. More specifically, the systems 200, 300 are configured to extract the lithium core out of a lithium-ion battery cell. The systems 200, 300 may be fully automated, partly automated and/or partly

operator activated. Whilst the systems 200, 300 are described as dismantling lithium-ion batteries, they may alternatively be used to dismantle other similar batteries that have a material core that can be extracted. Examples of alternative types of batteries are sodium-ion batteries, lithium-sulphur batteries and hydrogen fuel cells, or any other battery cells that have preferably a cylindrical shape. The batteries that can be dismantled by the systems 200, 300 may not be limited to the geometries of the cells referenced above.

[0048] The system of figure 2 illustrates two parallel machining pipelines 202a, 202b. It would be appreciated that the system can be operated using an arbitrary number of single or parallel working pipelines. That is, the system of figure 2 comprises a first machining pipeline and a second machining pipeline. Each pipeline has the same combination of components. Duplicating the number of machining pipeline doubles the efficiency of the dismantling system (i.e., the number of batteries that can be processed by the system). However, it would be appreciated that the system of figure 2 may only require one of the two pipelines 202a to function. For the purposes of the disclosure below, only the first of the pipelines 202a will be considered.

[0049] The systems 200, 300 comprise a number of common components. The systems of figures 1 and 2 comprise at least one battery carrier 204a, 204b, 304. The battery carrier 204a, 204b, 304 may otherwise be referred to as a workpiece carrier. The system may comprise multiple battery carriers, as illustrated by carriers 204a and 204b in figure 2. Each battery carrier 204a, 204b, 304 is configured to house at least one battery cell. Preferably the battery carrier 204a, 204b, 304 is configured to house a plurality of battery cells. The ability of the battery carrier 204a, 204b, 304 to house multiple battery cells means that these cells can be processed simultaneously, or in very quick succession, increasing the speed of the dismantling process. The battery carrier 204a, 204b, 304 is described in further detail below. From this point on, reference to "the battery carrier" will be understood to refer to each battery carrier of the system 200, 300.

[0050] The systems 200, 300 also comprise a transportation means 206, 306 that is configured to carry the one or more battery carrier 204a, 204b, 304 through the system. By extension, the transportation means 206, 306 is configured to carry the cells that are housed by each battery carrier through the system 200, 300. Each system 200, 300 has a first end 246, 346 and a second end 248, 348. The first end 246, 346 may be referred to as an input end, or pick-up location, as it is the end of the system from which the battery carrier 204a, 204b, 304 starts its journey through the system. The second end 248, 348 may be referred to as an output end, or exit region, as it is the end of the system at which the battery carrier ends its path through the system. The second end 248, 348 may comprise a lift or extended outfeed means (e.g., a conveyor belt) to transport battery carriers away from the system after the machining process is complete. The transportation means 206, 306 is configured to carry the

battery carrier 204a, 204b, 304 from the first end to the second end of the system. The transportation means carries the battery carrier in a first direction 224, 324 through the system. The first direction 224, 324 in systems 200 and 300 can be a straight line. This means that, in figures 2 and 3, the first direction 224, 324 is the same at all points along the path of the battery carrier 204a, 204b, 304 through the system. The first direction in figures 2 and 3 is a lateral direction (i.e., in a horizontal plane, or perpendicular to a vertical (y) axis). In figures 2 and 3 the first direction 224, 324 extends along the x-axis. In other examples, the first direction 224, 324 may extend along the z-axis. In yet other examples, the path of the battery carrier 204a, 204b, 304 through the system may be curved or irregular. In these examples, the first direction 224, 324 may vary depending on the position of the battery carrier along its path. In yet other examples, the path of the battery may be at an angle to the horizontal.

[0051] The battery cells may be carried by the battery carrier 204a, 204b, 304 so that their length (i.e., the dimension that extends between their terminals 124, 126) extends across the width of the transportation means 206, 306. The width of the transportation means 206, 306, in figures 2 and 3, is the dimension of the transportation means that is perpendicular to the first direction (i.e., the z-axis in figures 2 and 3). Battery cells are referenced by numeral 208 in figure 2. The battery cells may be housed within the battery carrier so that at least a portion of each battery cell, along its length extends externally of each side of the battery carrier. The battery carrier enables the precise alignment of battery cells within the dismantling system, and therefore ensures the reliable machining of cells by the system.

[0052] The systems of figures 2 and 3 further comprise a number of processing stations, or machining stations, located relative to the transportation means 206, 306 at different locations along the path of the battery carrier. The processing stations are configured to enable the extraction of the lithium core out of the battery cells that are housed within the battery carrier 204a, 204b, 304.

[0053] The first machining station of the systems 200, 300 is a first cutting station 210, 310. The first cutting station 210, 310 is configured to apply at least one cut to the battery cells housed within the battery carrier 204a, 204b, 304. More specifically, the first cutting station 210, 310 is configured to apply two cuts to the battery cells. The two cuts may be applied simultaneously. More specifically purpose of the first cutting station 210, 310 is to remove the terminals of the battery cell. This opens up the battery by removing the battery case on both ends of the battery cell, thus exposing the battery cell interior materials at either end of each battery cell. In order to remove the battery cell terminals or ends, the battery cell must be cut at both of its ends in a direction that is perpendicular to its length (i.e., perpendicular to the dimension that extends between its first and second ends). In figures 2 and 3, the direction in which the battery cell is cut extends along the x-axis.

[0054] The first cutting station 210, 310 comprises first and second cutting tools 218, 220, 318, 320. The first and second cutting tools 218, 220, 318, 320 are positioned on opposing sides of the transportation means 206, 306. That is, the first and second cutting tools 218, 220, 318, 320 are opposite each other across the transportation means 206, 306. More specifically, the first cutting tool 218, 318 is located on a first side of the transportation means 206, 306, and the second cutting tool 220, 320 is located on the second side of the transportation means. The first and second cutting tools are located on opposite sides of the width of the transportation means 206, 306. The first and second cutting tools 218, 220, 318, 320 are aligned parallel to the length of the transportation means (i.e., parallel to the first direction 224). This means that the cutter of each cutting tool 218, 220, 318, 320 is aligned in a direction that is parallel to the first direction 224, and therefore that each of the first and second cutting tools 218, 220, 318, 320 is able to interact with a respective end of the battery cell.

[0055] In a first example, each of the first and second cutting tools 218, 220, 318, 320 comprises a blade that is configured to cut (i.e., to apply a cutting force to) the battery cell. However, it would be appreciated that other types of cutting tools are available, such as laser cutters, thermal cutters, other saws, blades, wires, or alternative cutting tools. In some examples, the cutting tools may be cryogenic tools that perform cryogenic machining. In preferred examples, the cutting tools do not require any cooling or lubricant to perform their machining operations. However, in alternative examples, cooling and lubrication can be supplied to the cutting tools during machining operations (e.g., via gaseous or liquid solutions). Each of the first and second cutting tools is configured to cut across the width, or diameter, of a battery cell (i.e., perpendicular to its length). Thus, each of the first and second cutting tools 218, 220, 318, 320 is configured to apply a cut in a second direction 230, 330 that broadly opposes the first direction 224, 324. That is, the cutting force employed by the cutting tools may generally act in an opposite direction to the direction of travel of the battery carrier. The term "generally" is used because it is understood that some tools cut at an angle to the horizontal. However, in all cases a horizontal component of the cutting force of the first and second cutting tools opposes the first direction 224, 324. Because the first and second cutting tools 218, 220, 318, 320 are opposite each other, the tools may apply their cuts at the same time (i.e., simultaneously). Alternatively, the first cutting tool 218, 318 may apply its cut before the second cutting tool 220, 320, or in the second cutting tool may apply its cut before the first cutting tool.

[0056] The consistent positioning of the battery cells within the battery carrier 204a, 204b, 304 means that the cutting blades 218, 220 of the first cutting station are able to cut the cells at pre-specified and predetermined positions. In some examples of systems 200, 300 the

positioning of the blades 218 and 220 are changeable/ adjustable depending on the feedstock batteries (i.e., the type of battery cell that is to be dismantled).

[0057] The second machining station of the systems 200, 300 is an optional machining station. This station is referred to as a second cutting station 212, 312. The second cutting station 212, 312 is configured to apply a further cut to the battery cells housed within the battery carrier 204a, 204b, 304. More specifically purpose of the second cutting station 212, 312 is to cut along the length (i.e., the long edge, or mantle) of the battery cell to further expose the battery interior materials. Furthermore, the cut of the second cutting station can be used to relieve any enclosing force that is imparted onto the battery interior materials to enable the removal of the interior materials without the resistance of friction or other adhesive forces. Thus, the second machining station is advantageously used for battery cells that have components that are secured together inside their casing by adhesives or other attachment means, or spent battery cells that have interior materials that have expanded within their casing. In order to extract the battery cell interior materials, composing of cathode, anode, and separator, the battery cell must be cut at its first end in a direction that is parallel to its length (i.e., perpendicular to the dimension that extends between its first and second ends).

[0058] The second cutting station 212, 312 comprises at least one third cutting tool 222, 322. The third cutting tool 222, 322 is described as such because it is different to the first and second cutting tools. As with the first and second cutting tools, the third cutting tool 222, 322 may comprise a blade, or alternatively may comprise a laser or other suitable cutting tool, or an array of cutting devices or tools. In some examples, the cutting tools may be cryogenic tools that perform cryogenic machining. In preferred examples, the cutting tools do not require any cooling or lubricant to perform their machining operations. However, in alternative examples, cooling and lubrication can be supplied to the cutting tools during machining operations (e.g., via gaseous or liquid solutions). The third cutting tool 222, 322 is located on the first side of the transportation means 206, 306. That is, the third cutting tool 222, 322 is located on one of the two sides of width of the transportation means 206, 306. The third cutting tool 222, 322 is aligned perpendicularly to the length of the transportation means (i.e., perpendicularly to the first direction 224, 324) or moving direction of 224, 324, which in Figure 2 and 3 is represented by the x-direction. This means that the cutter of the third cutting tool 222, 322 is aligned in a direction that is perpendicular to the first direction 224, 324.

[0059] The third cutting tool 222, 322 is configured to cut into the length of a battery cell. Thus, the third cutting tool 222, 322 is configured to apply a cut to the cell in a third direction 216, 316 that is broadly perpendicular to the first direction 224, 324. That is, the cutting force employed by the third cutting tool may generally act in a direction that is perpendicular to the direction of travel of the battery carrier. This means that a horizontal component of the cutting

force of the third cutting tools is perpendicular to the first direction 224, 324. In figures 2 and 3 the third direction 216, 316 extends along the z-axis.

[0060] The third machining station of the systems 200, 300 is an extraction station 214, 314. The purpose of the extraction station 214, 314 is to remove the cell interior materials, including the electrode and separator foils or layers from inside a battery cell. More specifically, the extraction station 214, 314 is configured to apply a pressing force to a first end of the battery cell and to collect the battery cell interior materials from the battery cell at a second end.

[0061] To this end, the extraction station 214, 314 comprises a pressing means 226, 326 and an extraction means 228, 328. The pressing means 226 is configured to press material out of a first end of the battery cell. The extraction means 228, 328 is configured to extract the material from a second end of the battery cell. The pressing means 226, 326 comprises a pressing tool which may be of any suitable type. The pressing tool may be manually operated (e.g., operated by an operator) or may be mechanically/electrically operated. The pressing tool may be a pin, a shaft or another form of extrusion not limited to mechanical methods. The pressing tool may, in one example, be an air gun or other air ejection tool that is configured to eject highly pressurised air (or another suitable gas) towards the first end of the battery cell. Where the pressing tool is an extruded mechanical tool, the pressing tool comprises a face at its extruded end that is configured to contact the first end of the battery cell. The face of the pressing tool may have a surface area that is smaller than the surface area of the first end of the battery cell. The pressing tool may therefore be configured to be inserted within the battery cell. The pressing tool is further configured to be able break through a layer of material that is stuck, glued, or fixed to the battery cell case or exterior, and to move through the battery cell towards the second end of the cell so as to push out the battery cell interior materials of the cell. The pressing means 226, 326 is moveable in the third direction 216, 316 on the first side of the transportation system. That is, the pressing means 226, 326 is moveable in a direction that is parallel to the cutting direction of the third cutting tool 222, 322. This means that the pressing means 226, 326 can be moved along the length of the battery cell, which is aligned along the axis along which the third direction 216, 316 extends.

[0062] The extraction means 228, 328 is located on a second side of the transportation means 206, 306 to the pressing means 226, 326 (i.e., opposite the extraction means across the width of the transportation means). This means that the extraction means 228, 328 faces the second side of the battery cell. The extraction means 228, 328 is configured to extract material from a second end of the battery cell. The extraction means 228, 328 is configured to extract, or remove, the battery cell interior materials from the second side of the battery cell. The extraction means 228, 328 may provide a channel, or path, to move the material away from the battery cell and workpiece carrier. The extraction means 228, 328 may transport the material to a collection vessel (not illustrated in figures 2 or 3). The extraction means 228, 328

may be enclosed, so that the material is contained within the means as it travels to its collection vessel. This means that the material is not exposed to the surroundings outside of the extraction means 228, 328, which is advantageous when in situations where the material is a hazardous material.

[0063] The systems 200, 300 may comprise subsequent linking belts (not illustrated) that transport the battery carriers away from the machining stations after dismantling of the battery cells is complete.

[0064] Whilst figures 2 and 3 illustrate specific arrangements of the combination of means and machining stations described above, it would be understood that alternative implementations of these means and stations could also be constructed using the description provided above.

[0065] Figure 4 illustrates an example of the first cutting station 210 that can be used in combination with systems 200, 300. The first cutting station comprises opposing first and second cutting tools 218, 220, 318, 320. As described above, the first and second cutting tools may be any suitable cutting tool. The first and second cutting tools may be the same type of cutting tool. The first and second cutting tools may comprise cutting blades. The cutting blades may be linear or rotary. Each of the cutting blades may be mounted to a corresponding rig, or blade holder, 250, 252. In the example illustrated in figure 4, each of the cutting tools 218, 220 comprise rotary blades. In a more specific example, each of the cutting tools 218, 220 may comprise circular saws. The circular saws may be flex disks or saw disks. The diameters of the saws may range between 10 and 300mm. The saws may have diamond cutting edges, or ceramic cutting edges, or any other non-electric conductive cutting edge. An advantage of the use of diamond and ceramic cutting tools is that these tools do not require use of a lubricant, which reduces machining complexity and resources. The saws may alternatively have any other cutting edge that does not lead to chipping or sparking with battery case materials, or specialized tools that have low heat conductivity. The circular saws may be rotatable about an axis 234. The axis 234 in figure 4 extends perpendicularly to the first direction 224, and parallel to the third direction 216. The axis may be the z-axis.

[0066] The first and second cutting tools 218, 220 may be electrically actuated. Where the first and second cutting tools comprise rotary blades, the blades of the cutting tools may each have a rotational speed of between 1,000 and 50,000 rpm. Alternatively, the blades of the cutting tools may each have a rotational speed of between 10,000 and 30,000 rpm. Each of the rotary cutting blades of cutting tools 218, 220 may be positioned on a respective tool spindle. Each tool spindle may be powered via a respective linkage or belt, with a first end of the linkage belt being connected to the spindle and a second end of the linkage/belt being connected to a power source (e.g., an electric motor) for driving the blade around the spindle. Thus, the first cutting station 210 (or 310) may, in total, comprise two cutting tools, each cutting

tool comprising a rotary cutting blade, an electric motor and a linkage or belt transferring power from the electric motor to the rotary cutting blade.

[0067] In the system 200 of figure 2, the cutting tools of the first cutting station are fixed with respect to the transportation means 206. That is, the rigs 250, 252 holding cutting tools 218, 220 may be fixed, or stationary, or held in place relative to the transportation means 206. In other words, the first and second cutting tools in the system 200 are fixedly mounted relative to the transportation means 206. This means that, whilst the blades may rotate about the axis 234, they do not physically move linearly in either the first direction 224 or the second direction 230 with respect to the transportation means 206. The cutting tools 218, 220 may be mounted directly to the transportation means (e.g., to an underside of the means). However, alternative designs or solutions are also possible, where the first and second cutting tools 218, 220 are mounted on moveable axis or rigs 250, 252 that can move along the direction 224, 230. In some other examples, the cutting tools may be indirectly attached to the transportation means.

[0068] In the system of figure 3, the cutting tools 318, 320 of the first cutting station 310 are moveable with respect to, or relative to, the transportation means. In this example, the spindle of the first and second cutting tools 318, 320 may be mounted to a moveable rig. The moveable rig may be a linear slide, or a linear unit. The linear slide/unit may be equipped with a servomotor. The combination of the rig and the servomotor may allow movement of the first and second cutting tools along at least two axes (e.g., travel along at least the z axis and the x axis).

[0069] Figure 5 illustrates an example of the second cutting station 212 that can be used in combination with systems 200, 300. As mentioned above, the second cutting station is an optional addition to the first and second cutting stations of the systems 200, 300. As with the cutting tools of the first cutting station 210, the third cutting tool 222 of the second cutting station 212 may be any suitable cutting tool. The cutting station may comprise one or more cutting tools. Each cutting tool 222 may be configured to cut a respective battery that is held by the battery carrier. Thus, the number of cutting tools on the second cutting station may be the same as the number of channels in the battery carrier. The number of cutting tools of the second cutting station may be a fraction of the number of channels in the battery carrier. The second cutting station may comprise a number of cutting tools that is greater than one, thereby allowing the station to operate on multiple battery cells at the same time. The second cutting station may comprise 10 cutting tools. The second cutting station may alternatively comprise 20, 40, or any alternative number of cutting tools. All of the cutting tools may be mounted on the same spindle 236. Each cutting tool comprises a cutting blade. The cutting blade may be linear or rotary. The cutting blade may be mounted to spindle 236. In the example illustrated in figure 5, the cutting station comprises multiple cutting tools 222. In a more specific example, each of the cutting tools may comprise circular saws. The circular saws may be flex disks or

saw disks. The diameters of the saws may range between 10 and 300mm. The saws may have diamond cutting edges, or ceramic cutting edges. The circular saws may be rotatable about an axis 240. The axis 240 in figure 5 may extend along the length of the spindle 236. The axis 240 may be parallel to the first direction 224, and perpendicular to the third direction 216.

[0070] The one or more third cutting tools 222 may be electrically actuated. Where the third cutting tools 222 comprise rotary blades, the blades of the cutting tools may each have a rotational speed of between 1,000 and 50,000 rpm. Each of the rotary cutting blades of cutting tools 218, 220 may be positioned on a respective tool spindle. The cutting tools 222 are spaced apart from each other along the spindle. The tools 222 may more specifically be spaced apart by a predetermined distance, wherein each distance is the same between adjacent tools. The distances between the cutting tools 222 of the second cutting station may correspond to corresponding distances between channel centre-points in the battery carrier (as described in further details below below).

[0071] In the systems 200, 300 the second cutting station is moveable with respect to, or relative to, the transportation means 206, 306. That is, the second cutting station is able to move in the third direction 216, 316 relative to the transportation means 206, 306 (e.g., forwards along the z axis). The second cutting station may also move in a direction that directly opposes the third direction 216, 316 (e.g., backwards along the z-axis). In this example, the spindle of the third cutting tools 222, 322 may be mounted to a moveable rig. The moveable rig may be a linear slide, or a linear unit. The linear slide/unit may be equipped with a servomotor. The combination of the rig and the servomotor may allow movement of the third cutting tools along at least one axis (e.g., travel along at least the z axis). The combination may allow movement along at least two axes (e.g., travel along at least the z axis and the x axis). The combination may allow movement along three axes (e.g., along the x, y and z axes and the x axis).

[0072] The cutting tools of the second cutting station may be mounted directly to the transportation means (e.g., to an underside of the means). In some other examples, the cutting tools may be indirectly attached to the transportation means. For example, the second cutting station may be mounted to the ground.

[0073] Figure 6 illustrates an example of the extraction station 214 that can be used in combination with systems 200, 300. The extraction station, as described above, comprises a pressing means 226, 326 and an extraction means. The extraction station may be mounted directly to the transportation means (e.g., to an underside of the means). Alternatively, the extraction station may be indirectly attached to the transportation means. For example, the extraction station may be mounted to the ground.

[0074] The pressing means is configured to apply a pressing force to a first end of a battery cell. The pressing means 226, 326 comprises at least one pressing tool. The pressing tool may be a pin. The pressing means may more specifically be a cylindrical pin. The cylindrical pins may have a length of between 60mm and 150mm. The pins may have any arbitrary shape with a diameter that depends on the shape and size of the battery cells to be processed by the system. In non-limiting examples the diameters of the pins may range between 10mm and 42mm. The cylindrical pins may be made of round polyamide or surface-hardened aluminium, or another alternative material that is preferably non-electrically conductive, e.g., alumina or diamond. Alternatively, the tips and surface of the pins may be layered by a non-conductive material. The pressing means 226, 326 may comprise one or more pressing tools. Each pressing tool may be configured to cut a respective battery that is held by the battery carrier. Thus, the number of pressing tools of the pressing means may be the same as the number of channels in the battery carrier. The number of pressing tools of the pressing means may be a fraction of the number of channels in the battery carrier. The pressing means may comprise 10 pressing tools. The pressing means may alternatively comprise 20, 40, or any alternative number of pressing tools. The pressing tools may be positioned on a permanently installed tool holder.

[0075] In the systems 200, 300 the pressing means 226, 326 is moveable with respect to, or relative to, the transportation means 206, 306. That is, the pressing means 226, 326 is able to move in the third direction 216, 316 relative to the transportation means 206, 306 (e.g., forwards along the z axis). The pressing means 226, 326 may also move in a direction that directly opposes the third direction 216, 316 (e.g., backwards along the z-axis). The pressing means 226, 326 may move via a linear slide, or a linear unit. The linear slide/unit may be equipped with a servomotor. The combination of the rig and the servomotor may allow movement of the third cutting tools along at least one axis (e.g., travel along at least the z axis). The combination may allow movement along at least two axes (e.g., travel along at least the z axis and the x axis). The combination may allow movement along three axes (e.g., along the x, y and z axes and the x axis).

[0076] The extraction station further comprises an extraction means 228, 328. The extraction means may comprise a tool holder fitted with at least extraction vessel 242. The extraction vessel 242 may be pin shaped, and may therefore be described as a pin. In one example, the extraction vessel 242 is a tube. The tube may be a hollow tube. The hollow tube may extend from a first end that faces the transportation means (i.e., the first end of the extraction means) to a second end. The first end of the tube may therefore interact with, or contact, a first end of the battery. Material may be ejected from a battery cell, as it is pushed from the cell by the pressing means, through guidance of the tubes in a predefined fixed position.

[0077] The extraction means 228, 328 may comprise one or more extraction vessels 242. Each extraction vessel 242 may be configured to extract material from a respective battery cell that is held by the battery carrier. More specifically, each extraction vessel 242 may be configured to extract battery material from each battery cell independently, whilst preventing that material from coming into contact with corresponding material from the other battery cells that are being processed. This enhances the safety of the battery dismantling process and enables the tracking of extracted material back to the cell from which it was extracted.

[0078] The number of extraction vessels 242 of the extraction means may be the same as the number of channels in the battery carrier. The number of extraction vessels 242 of the extraction means may be a fraction of the number of channels in the battery carrier. The extraction means may comprise 10 extraction vessels 242. The extraction means may alternatively comprise 20, 40, or any alternative number of extraction vessels. As mentioned above, each tube may be connected at its second end to a collecting container, or collecting vessel 244. That is, the extraction means may comprise a collecting container at its second end. In one example, each extraction vessel 242 is connected to a corresponding collection vessel 244. In another example, each extraction vessel 242 is connected to a common collection vessel 244, which in some examples (explained in further detail below) can also be a conveyor or transportation belt to transfer the materials to another processing station automatically.

[0079] In the system 200 of figure 2 the first cutting station 210 is located before the second cutting station 212 along the first direction 224. That is, the first cutting station 210 is located closer to the first end 246 of the transportation means than the second cutting 212 station. This means that battery cells pass through the first cutting station 210 before they pass through the second cutting station 212. In an alternative example, the second cutting station 212 may be located before the first cutting station 210 along the first direction 224. In both examples, the extraction station 214 in the system 200 is located after the second cutting station 212 in the first direction. That means that the extraction station 214 is closer to the second end 248 of the transportation means than the second cutting station 212.

[0080] In the system 300 of figure 3 the first and second cutting stations 310, 312 are located at the same position in the system along the first direction 324. That is, the first and second cutting stations occupy the same area in the system, along the first direction 324. This means that the battery cells, in the system 300, arrive at the first and second cutting stations 310, 312 at the same time. However, because the first and second cutting stations 310, 312 are moveable relative to the transportation means 306 of system 300, they may still machine (or cut) the battery cells at different times.

[0081] Figures 7 and 8 illustrate two detailed versions of the battery carriers 204a, 204b to be used with the systems 200, 300. A first version of the battery carrier 204a is illustrated in figure 7. A second version of the battery carrier 204b is illustrated in figure 8.

[0082] The battery carrier 204a is configured to house a single battery cell. The battery carrier 204b comprises a channel 402 for housing a battery cell. The channel 402 extends through the battery carrier. That is, the channel 402 passes from a first end 412 of the battery carrier to a second end 414 of the battery carrier. The channel provides the battery carrier 204a with a hollow interior. In figure 7 the channel 402 of the battery carrier 204a is circular in cross-section with a centre-point 404. That is, the channel 402 in figure 7 is a cylindrical channel. In alternative examples the channel 402 have any suitable cross-section, such as square or rectangular (e.g., a slit or a slot). That is, the shape of the channel 402 may be varied. The dimensions of the channel 402 may also be varied. The shape and dimensions of the channel 402 may be selected so that they correspond to the shape of the battery cell to be held by the battery carrier. This means that the systems 200, 300 may be used to dismantle batteries of many different shapes and sizes, with the battery carriers being selected to ensure this.

[0083] The channel 402 may extend along a first axis 406. The battery carrier may be configured so that the battery cell is supported along its length by the carrier. The battery cell may be mounted within the channel 402 such that its ends extend out of the channel. That is, the length of the carrier (and therefore the channel) may be shorter than the length of the battery. Thus, a first end of the battery may extend out of a first side of the channel 402 and a second end of the battery may extend out of a second end of the channel. The walls of the channel 402 may be made of a special alloy or plastic coating that prevents inserted battery cells from turning, spinning or conducting electrical currents along the battery carrier 204a. The walls of the channel may be coated with any alternatively suitable material.

[0084] The battery carrier may further comprise a slot 408 that extends therethrough. The slot may be described as a second channel. The slot 408 may extend along the length of the carrier. That is, the slot may pass from a first end 412 of the battery carrier to a second end 414 of the battery carrier. The slot may be cut out of a surface 410 of the carrier or be pre-installed from previous manufacturing and production steps. The surface of the carrier from which the slot is cut may be an upper surface of the carrier (i.e., a surface that faces upwards when the carrier is mounted on the transportation means). The slot may extend downwardly from the upper surface of the carrier until it intersects the channel 402 to allow for the housing of battery cells. In an alternative example the slot may be cut from a lower surface of the carrier (i.e., a surface that faces downwards when the carrier is mounted on the transportation means). This alternative example may permit cutting operations to occur from the underside of the battery carrier instead of from the top of the carrier. Further, the slot 408 separates the upper surface of the battery carrier 410 into two sections. The two sections of the upper

surface of the battery carrier may have of same cross-sectional area, or alternatively may have different cross-sectional areas. The volume of the battery carrier may extend downward from each section of the upper surface 410 as far as is necessary to intersect with a housed battery cell which is placed within the channel 402 of the carrier. The slot 408 may have a width 416. The width of the slot 408 may range from 0.1 mm to 5 mm. The width of the slot may correspond to the width of the cutting tool of the second cutting station. The purpose of the slot 408 is to allow any cutting tool to cut the battery cell along the axis 406 of the carrier, without cutting into the workpiece carrier itself. This prevents inefficiencies that result from machining of the workpiece carrier. The battery carrier 204a may be stackable and combinable with other battery carriers 204a to form an array of battery carriers 204a. This arrangement can expand the number of battery cells to arbitrary length and number.

[0085] The battery carrier 204b may comprise the same components as the carrier 204a, but may be configured to house multiple battery cells. The battery carrier 204b comprises a plurality of channels 402a, 402b, 402c. Specifically, the battery carrier of figure 8 comprises three channels 402a, 402b, 402c, and can therefore carry three battery cells. Alternative battery carriers may have any number of channels that is greater than three. In one example, a battery carrier may have 10 channels. The battery carrier may alternatively have 20, 40, or any alternative number of channels. The distance "d" between the centre points 404a, 404b, 404c of each channel of the battery carrier 204b may be the same along the length of the battery carrier. That is, the channels 404a, 404b, 404c may be spaced evenly along the length of the battery carrier. This allows the battery carrier to incorporate a pre-defined battery positioning system to achieve precise battery placement. An advantage of this feature is that it ensures tight tolerances in a rapid machining process cycle time.

[0086] Generally, the geometry of the battery carrier 204a, 204b may be adaptable. That is, the size and shape of the battery carrier may be adaptable. More specifically, the length and width of the channel, and the shape of the channel, may be variable. The geometry of the battery carrier may be adapted in dependence on the geometry of the battery cells that are to be housed within the carrier. This allows the system as a whole to be usable for a range of different battery cells, increasing its versatility.

[0087] The battery carrier 204, 304 for use with the systems 200, 300 may be comprised of a flame and fire-retardant material. In an example, the battery carrier 204, 304 may be comprised of a fire-retardant copolymer. In a more specific example, the battery carrier 204, 304 may be comprised halogen-free flame-and fire-retardant copolymer with glass fibres. The battery carrier 204, 304 may be made of any other material with similar material properties. The battery carrier 204, 304 is constructed so that, in the event of a flame or fire situation, the coating melts and envelops the burning battery cell, preventing the ignition of the other cells.

[0088] The battery carrier may be placed on a tray 418 for travel through the systems 200, 300. The tray 418 is illustrated in figure 9. Figure 10 illustrates the assembly of battery carrier 204, 304 on tray 418 for transport through the system of figure 2 or 3. The size and shape of the tray 418 may be adapted depending on the size and shape of the battery carrier to be inserted into the system. The advantage and purpose of the battery carrier tray 418 is to allow for precision placement of battery cells into battery carriers 204a, 204b, 204, 304, while maintaining the required distances between battery cells within the battery carriers 204a, 204b, 204, 304. The tray 418 may be configured to fix to an underside of the battery carrier. The tray 418 may also be configured to fix at its own underside to the transportation means. Thus, the tray 418 may also enable the secure positioning of battery carriers 204a, 204b, 204, 304 through the system whilst the carrier is located within the tray. That is, the tray may prevent position changes of the battery cells during the precision machining and cutting operations.

[0089] The systems 200, 300 may be configured to accommodate a different battery carrier 204, 304 at each machining station. More specifically, the systems 200, 300 may be configured to accommodate a different battery carrier 204, 304 at each of the first cutting station 210, 310, the second cutting station 212, 312 and the extraction station 214, 314 at any one time. The ability of the system to accommodate multiple battery carriers 204, 304 at the same time also increases the production time for mass production.

[0090] The transportation means 206, 306 of the systems 200, 300 may be any suitable means that is capable of transporting the battery carriers 204, 304 from the first end to the second end of the system. The transportation means 206, 306 may move the battery carriers 204, 304 at a constant speed through the system. Thus, the transportation means 206, 306 may have a fixed speed, or feed rate. The transportation means 206, 306 may provide a flat surface on which the battery carriers 204, 304 can be transported. The transportation means may provide a moveable surface on which the battery carriers can be supported. In one example, the transportation means 206, 306 comprises a plurality of rollers. In an alternative example, the transportation means 206, 306 comprises at least one conveyor belt.

[0091] An example where the transportation means 206, 306 comprises a conveyor belt is illustrated in figure 2. In this example, the transportation means 206, 306 is a single conveyor belt. This is advantageous as it allows the battery carriers 204, 304 (and batteries) to move continuously through the system from the first cutting station 210, 310 to the second cutting station 212, 312 and to the extraction station 214, 314. The conveyor belt moves the battery carriers 204, 304 between the machining stations and also through the machining stations. The synchronised movement of different battery carriers 204, 304 is ensured, so the possibility of collision between carriers is minimised. The machining stations may be fixed with respect to the moveable conveyor belt.

[0092] In alternative examples, the transportation means 206, 306 may comprise a plurality of conveyor belts that are arranged along the length of the system. This alternative is illustrated in figure 3. That is, in figure 3 the system 300 comprises at least first conveyor belt 306a and a second conveyor belt 306b. The conveyor belts move the battery carriers between the machining stations 310, 312, 314. Note that, instead of conveyor belts, the transportation means of figure 3 could be alternative means (e.g., first and second sets of rollers).

[0093] The conveyor belts of the system in figure 3 may not move the battery carriers 204, 304 through the machining stations 310, 312, 314 in a continuous movement without stopping at the machining stations 310, 312, 314. In the example of figure 3, the carriers 204, 304 move from first conveyor onto a platform 326. The platform 326 may be stationary in the first direction as a system but may move in both the upward and downward directions along the y-axis. However, the platform 326 may be vertically moveable. That is, the platform 326 may be raisable. The platform 326 may move along the y-axis. This may be advantageous as the cutting stations may be positioned above the surface of the conveyors 306a, 306b. That is, the raisable platform 326 may be moveable to a position that is above the plurality of conveyor belts. The battery carriers 304 may be stationary when they are on the moveable platform 326. This means that the battery cells are stationary whilst they are being machined by the first, second and third machining stations 310, 312, 314. This may be advantageous as it increases the accuracy of machining cuts. Further, after the processing at the machining stations 310, 312, 314, the machining stations or platforms 326, 328 may lower the battery carrier 204, 304 back down and transfer the battery carrier 204, 304 via rollers or other means onto the conveyor belt 306, 306a, 306b.

[0094] The transportation means 206, 306 may be described as a first transportation means. This is because the system 200 of figure 2 may further comprise a second transportation means. The second transportation means 232, 332 may be located below the first transportation means 206, 306. The second transportation means 232, 332 may be the same type of means as the first transportation means (e.g., a conveyor belt). The second transportation means 232, 332 may move at the same speed, or feed rate, as the first transportation means. The purpose of the second transportation means may be to hold the vessels into which battery material is deposited from the extraction means. Thus, the vessels may travel on the second transportation means as the battery carrier travels through the extraction station, collecting material from the battery cells in the battery carrier 204, 304.

[0095] The systems 200, 300 may be mechanically actuated. Alternatively, the systems 200, 300 may be electrically actuated. Where the systems are electrically actuated, the transportation means and each machining station of the system may comprise its own processor. The system may further comprise a processor 238, 338 (e.g., a master processor) configured to monitor and individually control processes of one or more of the transportation

means 206, 306, the first cutting station 210, 310, the second cutting station 212, 312 and the extraction station 314, 316. The master processor may communicate with the individual processor of each station/transportation means of the system to synchronise operation of the system. The processor 238, 338 may otherwise be referred to as a main head controller. The processor 238, 338 may be configured to monitor and control the machining, or battery dismantling, process. The processor 238, 338 may be configured to manage programming of the process. The processor 238, 338 may be configured to synchronize, or coordinate, movement of the machining stations and transportation means of the systems 200, 300. The processor 238, 338 may be a programmable logic controller (PLC). The processor 238, 338 may be part of a control system that controls systems 200, 300. The processor 238, 338 may operate using open loop control. Alternatively, the processor 238, 338 may operate using closed loop control. In this alternative example the systems 200, 300 may comprise one or more sensors configured to provide feedback to the processor 238, 338 so that actuation of the machining stations and/or transportation means can be coordinated accordingly.

[0096] Figure 11 illustrates a method 500 for dismantling a battery cell. The method of figure 11 corresponds broadly to the function of the systems 200, 300 that have been described above. However, it would be appreciated that the method of figure 11 may be carried out by an alternative system to the systems 200, 300, provided that the alternative system is configured to perform such steps.

[0097] At step S502 a battery cell is housed in a battery carrier. The battery cell may be housed so that its first and second ends are exposed. That is, the first and second ends of the battery cell may protrude out of the battery carrier. The battery carrier may be a carrier as described above with respect to figures 2, 3, 7 and/or 8. At step S504 the battery carrier is carried through the system in a first direction. This means that the battery cell is carried through the system by the battery carrier. The battery cell may be positioned inside the battery carrier so that its length extends perpendicularly to the first direction.

[0098] Then, at step S506 the battery cell is cut at a first end and a second end of the battery in a second direction that opposes the first direction. Cutting the first and second ends of the battery results in the removal of the terminals of the battery exposing the interior battery materials. The first and second ends of the battery may be cut at the same time (i.e., simultaneously). Alternatively, the first end of the battery may be cut before the second end of the battery, or vice versa.

[0099] Step S508 is an optional step. At step S508 the first end of the battery is cut in a third direction that is perpendicular to the first direction. The first end of the battery may be located on either end of the length of the battery cell. The battery may be cut at its first end towards the second end or at its second end towards the first end. The cutting the battery in this way along the predefined slot 418 at a predefined depth according to the battery case materials

wall thickness enables a precise cutting and opening of the battery cells fixated or housed in the battery carriers 204, 304 without cutting through the electrode layer, exposing or damaging the electrode layers.

[0100] Finally, at step S510 a pressing force is applied to a first end of the battery whilst material is extracted from a second end of the battery. The second end of the battery may be located on either end of the length of the battery cell. The second end of the battery opposes the first end of the battery along the length of the battery cell. The pressing force at the first end of the battery may force material from inside the battery to the second end of the battery from which it can be extracted. Extracting the material from the second end of the battery may comprise passing the material through an extracting means. The extracting means may enclose the material (i.e., protect it from the surroundings). The extracting means may transport the material to a collection vessel.

[0101] The method of figure 11 may, of course, may be performed sequentially for a plurality of battery cells, or alternatively may be performed simultaneously for a plurality of battery cells.

[0102] The system and methods described herein provide for a variable battery cell dismantling system that is not restricted to one direction or system of flow. In other words, the systems described herein (or systems for performing the method) are not restricted to linear systems, but rather are systems that can perform parallel, individual operations and work steps in order to dismantle one or more battery cells. Thus, a parallel and independent dismantling system is provided.

[0103] It will be understood that the above description of a preferred example is given by way of example only and that various modifications may be made by those skilled in the art. What has been described above includes examples of one or more examples. It is, of course, not possible to describe every conceivable modification and alteration of the above devices or methods for purposes of describing the aforementioned aspects, but one of ordinary skill in the art can recognize that many further modifications and permutations of various aspects are possible. Accordingly, the described aspects are intended to embrace all such alterations, modifications, and variations that fall within the scope of the appended claims.

CLAIMS

1. A battery cell dismantling system comprising:
 - a battery carrier, configured to house a battery;
 - a transportation means configured to carry the battery carrier through the system in a first direction;
 - a first cutting station comprising first and second cutting tools, the first cutting tool being located on a first side of the transportation means and the second cutting tool being located on a second side of the transportation means, each of the first and second cutting tools being configured to apply a cutting force in a second direction that opposes the first direction; and
 - an extraction station comprising:
 - a pressing means that is moveable in a third direction on the first side of the transportation means and configured to apply a pressing force to a first side of the battery cell, wherein the third direction is perpendicular to the first direction; and
 - an extraction means located on a second side of the transportation means and being configured to extract material from a second side of the battery cell.
2. The battery cell dismantling system of claim 1, further comprising a second cutting station comprising a third cutting tool, the third cutting tool being configured to apply a cutting force in the third direction.
3. The battery cell dismantling system of claim 1 or claim 2, wherein the battery carrier comprises one or more channels extending therethrough, each channel being configured to house a battery.
4. The battery cell dismantling system of claim 3, wherein each channel of the one or more channels is a cylindrical channel that extends from a first end of the battery carrier to a second end of the battery carrier.
5. The system of claim 4, wherein the battery carrier further comprises a slot extending from a third end of the battery carrier and intersecting with the channel.
6. The battery cell dismantling system of any preceding claim, the battery cell dismantling system further comprising a plurality of battery carriers, wherein the system is configured to accommodate a different battery carrier at each of the first cutting station, the second cutting station and the extraction station at the same time.

7. The battery cell dismantling system of any preceding claim, wherein the transportation means is a single conveyor belt.
8. The battery cell dismantling system of any of claims 1 to 6, wherein the transportation means comprises a plurality of conveyor belts that are arranged along the length of the transportation means.
9. The battery cell dismantling system of claim 8, wherein the transportation means further comprises a plurality of raisable platforms, each raisable platform being moveable above the plurality of conveyor belts.
10. The battery cell dismantling system of any preceding claim, wherein the first and second cutting tools are fixedly mounted relative to the transportation means.
11. The battery cell dismantling system of any of claims 1 to 9, wherein the first and second cutting tools are moveable relative to the transportation means.
12. The battery cell dismantling system of any preceding claim, wherein the first and second cutting tools are cutting tools that are rotatable about an axis that extends perpendicularly to the first direction.
13. The battery cell dismantling system of any preceding claim when dependent on claim 2, wherein the second cutting station is movable relative to the transportation means.
14. The battery cell dismantling system of claim 13, wherein the second cutting station is mounted to a linear slide unit.
15. The battery cell dismantling system of any preceding claim when dependent on claim 2, wherein the cutting tools of the second cutting station are circular saws.
16. The battery cell dismantling system of any preceding claim when dependent on claims 2 and 3, wherein the second cutting station comprises a plurality of cutting tools, and wherein the number of cutting tools in the second cutting station is the same as the number of channels in the battery carrier.
17. The battery cell dismantling system of claim 3, wherein the number of channels in the battery carrier is 10, 20 or 40 channels.

18. The system of any preceding claim, wherein the extraction station is coupled to a linkage so that it is movable relative to the transport system.
19. The battery cell dismantling system of any preceding claim, wherein the extraction means is a pin that extends from a first end that faces the transportation means to a second end.
20. The battery cell dismantling system of claim 19, wherein the extraction means comprises a collecting container at its second end.
21. The battery cell dismantling system of any preceding claim, wherein the transportation means is a first transportation means and the system further comprises a second transportation means that is located below the first transportation means.
22. The battery cell dismantling system of any preceding claim further comprising a programmable logic controller configured to monitor and individually control processes of one or more of the transportation means, the first cutting station and the pressing means.
23. The battery cell dismantling system of any preceding claim wherein the geometry of the battery carrier is adaptable.
24. A method for dismantling a battery comprising:
housing the battery in a battery carrier;
carrying the battery carrier through the system in a first direction;
cutting a first end and a second end of the battery in a second direction that opposes the first direction;
and
applying a pressing force to the first end of the battery in a third direction that is perpendicular to the first direction whilst extracting material from a second side of the battery.
25. The method of claim 24, further comprising cutting the first end of the battery in the third direction.