[0302] Thus, the present invention provides for integrating electronics, solid-state rechargeable batteries, supercapacitors and antenna on a single platform such as a credit card or implantable device.

[0303] Method of recycling and re-using solid-state lithium-ion batteries

[0304] **FIG. 28A** shows an elevation view of a battery **2800** having stacked cells **2801**. Each cell includes an anode tab **2802** and a cathode tab **2803**, wherein all of the anode tabs **2802** are soldered together, and all of the cathode tabs **2803** are soldered together. Optionally, battery **2800** is encapsulated with a potting material.

[0305] **FIG. 28B** shows a plan view of a single battery cell **2801** after recycling. In some embodiments, the anode tab **2802** and the cathode tab **2803** are "tinned" (covered with fresh solder) and/or solder bumped to facilitate reassembly soldering operations.

[0306] **FIG. 28C** shows a process **2810** used for recycling. Process **2810** includes providing batteries **2800** to be recycled into input bin **2820**. In some embodiments, the batteries are de-potted at de-pot station **2822**, de-soldered at de-solder station **2824**, tested at test station **2826**, and outputted into sorted output bins **2828** based on the testing results.

[0307] Of the 2 billion rechargeable batteries consumed in the United States in 1998, only about 300 million were actually recycled. That means about 1.7 billion recyclable batteries made it into landfills. Although more and more of these batteries are technically environmentally safe, this still represents a significant load on the landfill situation in the USA. The present invention provides a solution that will have its greatest impact as solid-state lithium-ion batteries begin to dominate the rechargeable battery market. In this invention, solid-state lithium-ion batteries have a date code and/or recycle value associated with them. Because of the very large (over 40,000) number of charge/discharge cycles possible with solid-state lithium batteries, the average expected life of a cell could exceed 100 years. It is therefore very likely that the product in which the cell is placed will lose its usefulness well before the battery cell is depleted. Thus, when the battery reaches the end of its useful life based on the obsolescence of the product it was in, the consumer will be enticed to recycle the battery based on the value returned to the consumer in exchange for recycling. This value could be a function of the date code and application the battery was used in. The recycler **2810** then disassembles the unit **2800**, tests the single cells **2801**, then rebuilds the cells in whatever configuration is most in demand at that time. The rebuilt unit **2800'** could then be sold at an appropriate cost and warranty on performance.

[0308] This invention relates to recycling of rechargeable batteries, specifically the recycling of batteries that are manufactured in such a way so as to allow the disassembly of the individual battery cells upon recycling.

[0309] For years the automotive industry has recycled certain high-cost components of the automobile. Using this philosophy, the present invention applies those principles to the recycling of rechargeable batteries. As battery technology advances, the batteries are actually outlasting the products they were designed for. The conventional solution is to depend on the consumer to recycle the no-longer useful battery by taking it to some place that will accept the battery. The data suggests that this is wishful thinking, as fully 80% of Americans do not recycle their rechargeable batteries. Rather, they throw them into the garbage and the battery ends up in a landfill. Although the newer battery chemistries are relatively benign to the environment, the sheer bulk of the disposed batteries can represent an enormous strain on landfills. This invention allows enticement of the consumer to recycle the batteries by offering a cash reward, or other inducement such as reduced cost on new batteries, in exchange for recycling. Since money is involved, this program should be able to be implemented on a wide scale making participation likely.

[0310] In one embodiment, rechargeable battery manufacturers are encouraged to manufacture their products in such a way that upon recycling, the battery can be broken down into individual cells and these cells rebuilt into "new" batteries. In some embodiments of the present invention provide such a recycling program, and provide batteries with features to facilitate recycling, for example, marking one or more of the cells of a battery with a code indicating such information as date of manufacture, voltage, capacity, value, composition physical size, and/or weight. An example is a cell-phone battery having a capacity of 1000 mAh (milliampere hours). Some embodiments involve the parallel assembly of approximately 10 individual cells into a battery pack that would have a capacity of 1000 mAh. These individual cells are fabricated on a grid that provides bonding tabs allowing the configuration of the cells in a variety of modes. Upon recycling, the batteries are de-potted, de-soldered and analyzed for robustness. Cells having data codes and test results indicating substantial life remaining would be repackaged according to market needs. In some embodiments, recycling rechargeable batteries involves the breaking down of the battery pack into individual cells which are tested and re-assembled into usable battery packs. Some embodiments include a method of determining the viability of recycled battery cells for use in rebuilt batteries such as measuring the charge-discharge voltage-current curve over one or more cycles. Some embodiments include a method of de-potting batteries such that the individual cells are accessible and not damaged, such as using a plastic potting compound that can later be dissolved using a solvent and/or heat that does not deteriorate the battery. Some embodiments include a method of disconnecting cells from the original battery pack and re-connecting into a new configuration, such as having solder tabs that extend beyond the battery pack so that the solder tabs can be desoldered without substantially heating the battery itself. Some embodiments include a recycling system based loosely on the system used by the automotive industry in rebuilding of starters, alternators etc. and the techniques used by lead acid battery outlets.

[0311] **FIG. 29A** shows a block diagram of a layer-deposition system **2960**. System **2960** has layer deposition sections **2962** much the same as those of **FIG. 2460** of **FIG. 24**B, except that it is set up to deposit layers onto wafers **2961** (or onto diced ICs **2510** rather than onto flexible substrates. **FIG. 29B** shows a perspective view of a partially processed wafer **2964** having battery material **2320** on wafer **2961** or IC **2410**.

[0312] **FIG. 29C** shows a block diagram of a layer-deposition system **2965**. System **2965** has layer deposition