applications as a hearing aid having an combined transducer-battery-amplifier device in order to provide a radio frequency-wave-rechargeable hearing aid which could be taken out of the ear at night and placed in a RF-emitting recharging stand (e.g., that of **FIG. 27M**), avoiding the need to replace batteries or even to electrically connect to an external recharging circuit.

[**0279**] In various embodiments, such an antenna or electromagnetic radiation receiving loop **2660** is fabricated on device **2202**, **2203**, **2203**, **2204**, **2206**, **2207**, **2208**, **2300**, **2400**, or **2500** (or **2700** described below) or other battery devices described herein. In some such embodiments, electromagnetic radiation received wirelessly by antenna **2660** can be such low-frequency radiation as 50-or 60-hertz magnetic radiation from a coil connected to house current (e.g., that of **FIG. 27L**). In other such embodiments, RF radiation such as radio, TV, cellular, etc. having frequencies up to and exceeding 2.4 GHz is received. In some embodiments, multiple antennae are used, e.g., one for transducing communications signals and another for receiving recharging signals. **FIG. 26B** shows a block diagram of a layer-deposition system **2660**. System **2660** is much the same as system **2560** of **FIG. 25**B, except that the battery material is deposited on the back of the sheet, i.e., on the side opposite the active parts or connections of circuit **2510**.

[**0280**] **FIG. 26C** shows a perspective view of a processed sheet **2669**. Sheet **2669** includes a plurality of devices or circuits **2510** each having a battery **2320** on the back. **FIG. 26D** shows a perspective view of diced final devices **2600** after being dices or cut apart. **FIG. 26E** shows a perspective view of wired diced final device **2600** after being wired, e.g., by wires **2615** and **2616** as shown, or by deposited traces (not shown) that extend electrical connections from the top to the bottom of device **2600**.

[**0281**] In some embodiments, a roll of flexible fabric **2661** suitable for use as a substrate for direct energy conversion has deposited on it the necessary elements and/or layers to form the desired unit (such as a photovoltaic cell) using roll-to-roll concepts. The roll is then taken to the energy deposition tool **2660** which is also configured to operate in a roll-to-roll mode. The battery **2320** is fabricated on the backside (the side opposite the active side of the device, e.g., the side having the light-reception face of a photovoltaic cell) of the roll. Electrical connection is made after fabrication using hardwire techniques, such as shown in **FIG. 26E**.

[**0282**] In other embodiments such as shown in FIGS. **24**B-**24**F, a roll of flexible fabric **2461** suitable for use as a substrate for direct energy conversion (e.g., for a photovoltaic cell) is deposited with materials to form a solid-state lithium battery using roll-to-roll concepts in system **2460**. The resulting roll **2463** is then taken to the direct energy conversion materials deposition tool **2465** which is also configured to operate in a roll-to-roll mode. The direct energy conversion material **2430** is deposited directly on the solid-state battery **2320**. In some embodiments, electrical connection is made through vias formed during battery and device fabrication such as shown in **FIG. 23**.

[**0283**] In yet other embodiments, roll **2461** above is replaced by a different substrate, such as wafer **2961** of **FIG. 29A** described below, also suitable for use in direct energy conversion. The fabrication tools **2960** and **2965** are also configured to handle the new substrate form factor such as square plates or round wafers.

[**0284**] In still other embodiments, roll **2661** above is replaced by a different substrate, such as wafer **2971** of **FIG. 29E** below, also suitable for use in direct energy conversion. The fabrication tools **2960** and **2965** are also configured to handle the new substrate form factor such as square plates or round wafers.

[**0285**] Thus, the present invention provides a method for integrating solid-state lithium batteries with direct energy conversion materials on a flexible fabric. Further, the present invention provides a method for integrating solid-state lithium batteries with direct energy conversion materials on a rigid substrate.

[**0286**] **FIG. 26F** shows a perspective view of a hearing aid **2690** incorporating a wired diced final device **2600**. In some embodiments, device **2600** includes a photovoltaic cell **2650** for recharging battery **2320** the operates hearing aid **2690**. In some embodiments, sound transducers of conventional materials such as piezo-electric materials are deposited as layers by system **2660** to be used as the microphone and speaker of hearing aid **2690**.

[**0287**] **FIG. 27A** shows a plan view of a starting substrate **2710** of an embodiment that will have an integrated battery and device sharing a common terminal. **FIG. 27F** shows an elevation view of the starting substrate of **FIG. 27A**. **FIG. 27B** shows a plan view of the substrate **2710** of **FIG. 27A** after deposition of the integrated battery **2320** and device **2430** sharing a commnon terminal. In some embodiments, integrated battery **2320** and device **2430** are a thin-film battery and supercapacitor having electrical connections **2322**, **2324**, and **2431** such as shown and described in **FIG. 24A** above. **FIG. 27G** shows an elevation view of the partially built device of **FIG. 27B**. **FIG. 27C** shows a plan view of the substrate of **FIG. 27B** after placing and wiring a separately fabricated chip **2440** connected by wires **2441**, **2442**, and **2443** to the integrated battery **2320** and device **2430** sharing common terminal **2324**. **FIG. 27H** shows an elevation view of the partially built device of **FIG. 27C**. **FIG. 27D** shows a plan view of the substrate **2710** of **FIG. 27C** after placing and wiring a loop antenna **2750**. **FIG. 271** shows an elevation view of the partially built device of **FIG. 27D**. **FIG. 27E** shows a plan view of the final device **2700** having the partially built device of **FIG. 27D** after a top encapsulation layer **2760** has been deposited. **FIG. 27J** shows a cross-section elevation view of the device **2700** of **FIG. 27E**. The elevational views of FIGS. 27E-27J are not to scale. In some embodiments, device **2700** is approximately the size and thickness of a common credit card. In some embodiments, a magnetic strip **2770** and raised lettering **2780** are also fabricated on device **2700**.

[**0288**] **FIG. 27K** shows an perspective view of the device of **FIG. 27E** at a magnetic-recharging station. In the embodiment shown, coil **2790** uses house current to generate a 60 Hz magnetic field, and together with coil **2750**, form a transformer inducing current flow in coil **2750**, which is rectified and used to recharge battery **2320**.

[**0289**] **FIG. 27L** shows an perspective view of a device **2700** of **FIG. 27E**, but further including a photovoltaic cell **2650**, at a light-recharging station that includes lamp In some embodiments, device **2700** is fabricated in a shape to