A "Smart" Reserve Battery Provides Power as Needed

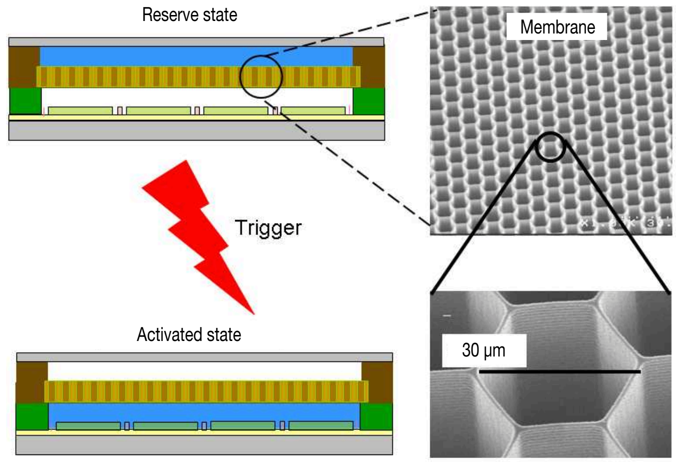

Figure 1. A schematic of the battery action depicting the battery transitioning from the inactive state to the active state as the electrolyte passes through a porous silicon membrane. Shown on the right are a superhydrophobic membrane chip (top) and the electrode chip (bottom). Overall dimensions are 20 cm × 20 cm; the dimension of the active area of the membrane and electrode are 1 cm.

The Pitch

Battery technology is still one of the most efficient and cost-effective ways to store energy and provide power for a wide range of applications. While many significant changes have occurred over time with respect to form, fit, and function, problems remain when using currently available batteries in certain consumer, industrial, and military applications, particularly those that depend on reliability and convenience. mPhase Technologies (Little Falls, NJ) is developing a "smart" reserve battery, which is a primary battery typically designed for a special purpose such as emergency or military use.

There are basically two types of batteries: primary batteries, which are nonrechargeable energy storage units that are discarded or recycled after discharge (these include alkaline, lithium, silver oxide, zinc-air, and zinc-carbon/zinc-chloride), and secondary batteries, also known as rechargeable batteries (these include nickel-cadmium, nickel-metal hydride, lithium-ion, lead-acid, and a range of other types based on electrochemical systems). Markets for secondary batteries include motor vehicles (both starting/lighting/ignition and hybrid/fuel cell vehicle batteries), backup (or standby) power, motive power, portable devices, and consumer electronics.

According to the Freedonia Group (Report No. 2178), world demand for primary and secondary batteries is forecast to increase approximately 6.5% annually from $55.5 billion in 2006 to $104.3 billion in 2016. Growth will be driven by demand for battery-powered products like cellular phones and digital cameras. Market gains will also be assisted by an ongoing shift toward more costly batteries (e.g., rechargeable lithium cells) that deliver improved performance for high-drain electronics.

The Technology

In the reserve battery, the electrolyte is usually stored separately from the electrodes, which remain in a dry inactive state. The battery is only activated when it is actually needed by introducing the electrolyte into the active cell area containing the electrodes. This has the dual advantage of avoiding deterioration of the active materials during storage and eliminating the loss of capacity due to self-discharge before use.

The production of the Smart Battery by mPhase is enabled by nanotechnology, microfluidics, and microelectromechanical system fabrication methods. The result is a proprietary membrane made using standard silicon processing techniques used in the semiconductor industry (e.g., lithography and etching) that keeps the electrolyte physically separated from the electrodes until activation is needed (see Figure 1). Until then, the battery remains in a quiescent state with no self-discharge, power drain, or leakage. Activation can occur by a remote control switch or a triggering mechanism such as a mechanical jolt, electrical pulse, or wireless rf signal, thereby providing Power On Command™-stored energy when and where it is needed. This enables significantly longer shelf life compared to a typical battery (infinite in theory because there is no self-discharge prior to activation). This is valuable in situations where reliable power is critical, such as in emergency or medical equipment, remotely accessible sensors, or for the millions of radio frequency identification tags sitting in inventories.

In addition, individual cells, or groups of cells, can be independently addressed and therefore switched on at different times or under different operating conditions. A single battery can consist of several subcells that can be triggered individually, independent of each other, or sequentially by triggering the next unused cell as each reaches its limit. For example, a Smart Battery based on chemistry that typically lasts 10 years can have three groups of cells that turn on sequentially as one group exhausts its capacity, thereby providing up to 30 years of uninterrupted service. It also makes practical the idea of integrating different chemistries (electrodes and electrolytes) into a single system. This potentially allows for a single battery to be built that runs continuously under temperature extremes from very hot to very cold.

The unique architecture of the battery makes it adaptable to multiple configurations, some that could even consist of integrating the battery architecture directly onto the circuit board during the manufacturing process to provide reserved power for electronic devices.

The Smart Battery has already been used in a reserve zinc chloride battery configuration trial. It activated at an extremely high g-force on being shot out of an Army tank and provided continuous power over a four-mile trajectory. Although the focus to date has been on zinc chloride and lithium batteries, the Smart Battery can accommodate any chemistry using a liquid electrolyte, depending on the energy and power requirements. The size, shape, and weight of the battery can be adjusted to meet the requirements of the application.

Opportunities

mPhase is in the advanced development stages of design and is open to discussing earlier adopter opportunities for joint application, collaborative development, and licensing.

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