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Batteries for Wearable Technologies

Introduction

Wearable technology has experienced increased user adoption with advances in small-scale electronics. In order for these wearable technologies to operate they require special batteries that can provide power safely to the device. Ideally, these batteries are small, light weight, run at cool temperatures, and have long battery life cycles. This paper reviews current battery technologies for use in wearable devices.

Lithium-ion Batteries

Lithium-ion batteries are small batteries that use the movement of lithium ions between the positive and negative terminals to provide power [1]. These rechargeable cells replaced nickel-cadmium cells in most small-scale electronics. Lithium-ion batteries have twice the energy density of nickel-cadmium batteries with the potential to exceed that number. In addition, their high output voltage of 3.6 volts allows for a single cell to provide sufficient power in most scenarios. A device that required the same voltage would need three nickel-cadmium cells, each providing 1.2 volts. Lithium-ion cells are low maintenance and cause little harm to the environment when disposed [2].

While lithium-ion batteries have many useful properties, there are some drawbacks. Lithium-ion batteries are fairly fragile and require protection circuitry for safe operation. When overcharged, almost empty, or punctured, lithium-ion devices can become unstable and sometimes catch fire. Because of this, lithium-ion batteries are subject to stricter standards than traditional, lead acid batteries [3]. Although the lithium-ion battery may be more expensive than lead-acid batteries,

their long lifespan and high power output make them a better value over their lifetime [4].

Lithium-polymer Batteries

Lithium-polymer batteries are similar to lithium-ion batteries in most ways. The difference lies in the separator within the cell. Lithium-polymer uses a micro porous electrolyte, replacing the traditional porous electrolyte in lithium-ion cells [5]. Lithium-polymer cells can provide higher energy density than lithium-ion cells and are manufactured in various shapes and sizes. However, these cells have a manufacturing cost that is typically 10-30 percent higher than traditional Lithium-ion cells [6]. These cells are still burdened by the safety concerns of the traditional Lithium-ion cell.

Thin-film Batteries

Thin-film batteries are a form of battery that is created through 3D printing. The primary battery type is still lithium-ion, however these batteries can be printed directly into objects or onto circuitry in an ultra thin structure [7]. Because these batteries are 3D printed, there is ample room for customization of size and shape. Thin-film batteries can provide high energy density for low cost. Unlike traditional Lithium-ion batteries, thin cell batteries are typically much safer to use and don't require protective circuitry. While good for applications where very thin batteries are needed, the energy capacity of the battery is determined by volume. This means a much larger area is required for thin batteries than the traditional coin cell [8]. Many companies offer different primary and secondary thin-film batteries for purchase including Enfucell and EnFilm [9][10].

Graphene Batteries

Graphene batteries are an experimental new battery type that involves enhancing traditional electrodes with graphene. Using graphene in batteries results in longer battery life, shorter charge time, and higher energy density [11]. While graphene batteries have the potential to have the highest energy density of all

batteries, they are very expensive to purchase. This technology is still in development, with very few companies selling production ready graphene batteries.

Future

It is believed that graphene based batteries will provide the highest energy density of any battery. Many different companies are looking into using graphene to enhance various battery technologies including lithium-ion graphene batteries and 3D printed graphene batteries. Creating a safe, small, and fast charging battery will be key in creating wearable/mobile electronics for consumer use.

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