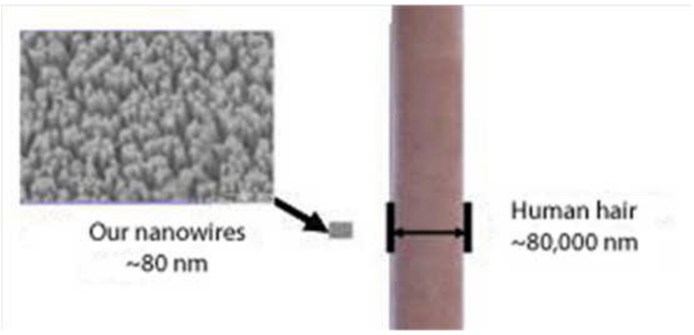
Nanowire-based Battery Concept

Thin film and nanowire-based batteries will typically have some advantages, including:

- provide more continuous power and higher peak pulses;
- allow for both rechargeable and single-use devices;
- utilize a smaller space; and
- cost less

Figure 1: Each nanowire is about 1/1000th the diameter of a human hair



At a fundamental level, batteries consist of three parts: an anode (the - pole), a cathode (the + pole) and an electrolyte. When a connection is made between the + and - poles, a chemical reaction creates power.

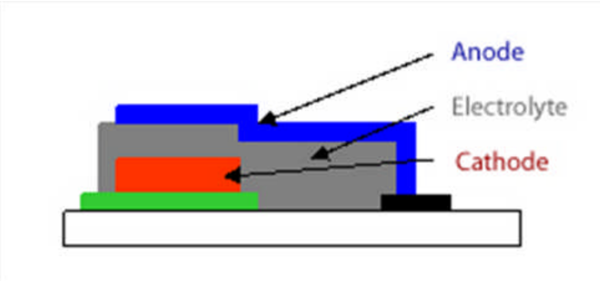
Many companies and research institutions are working on "thin film" batteries. These are batteries that are created using many of the same techniques used to create integrated circuits (ICs). They start with a wafer (a flat disc that may be made of silicon, glass, ceramic, or other material; see figure 2). It could be 2" or as much as 12" or larger in diameter.

Figure 2: A typical 4" wafer

The thin film battery manufacturer will then deposit battery materials on the wafer in special configurations. A simple diagram is shown in figure 3.

The amount of energy the battery can produce is determined by the mass of the anode and cathode (that is, the more material there is, the more atoms there are, therefore, the more electrons are available to provide power) and the chemical reactivity of the materials.

Figure 3: Diagram of a thin film battery



The surface area between the active material (anode and cathode) and the electrolyte, however, is akin to the doorway for the current flow. The larger the surface area, the lower the battery internal resistance and the larger the current flow. Figure 4 highlights the surface area of a thin film cathode. Current flow between the cathode and electrolyte is typically a limiting factor in thin film battery performance.

Nanowire cathodes are attractive because they increase the surface area by a very large amount. Therefore, they can provide a greater power burst in a relatively small footprint (see figure 5).

OK . . . So What?

These batteries can be made in different chemistries and different configurations, meaning they can be rechargeable or not, and can fit into a variety of applications, including:

- "smart" cards
- RFID tags
- MEMs, NEMs
- military ID
- sensors
- and more

Figure 4: Surface area of a thin film battery cathode

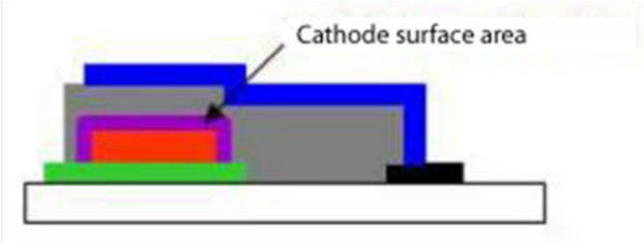
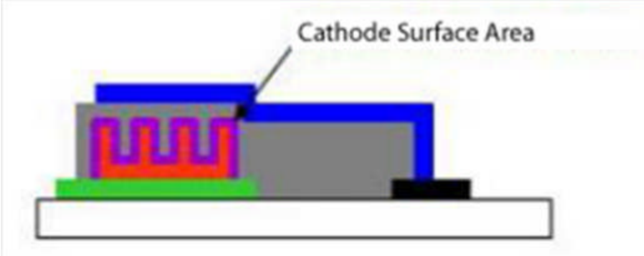


Figure 5: Surface area of a nanowire-based cathode



So, a typical battery for one of these applications might measure about the size of a postage stamp and about 2/3 the thickness of a credit card. And, it would be relatively inexpensive to manufacture.

You may still be asking yourself "so what"? Many active RFID tags use printed versions of this concept. In addition, many people in the United States are not familiar with "smart" cards and other potential market opportunities for microbatteries. "Smart" cards are popular in Europe and the Pacific Rim, but not so much in the U.S. (yet).

So, the answer to the "so what" question is simple: if anyone can supply a battery for these applications that meets the price and performance targets these manufacturers are seeking, they will have access to a market that was estimated to go over $3 billion by 2012 (according to a 2005 report from Nanomarkets, an independent market research firm).

This is why (by our count) there are over 50 companies in the US alone (not counting dozens of research institutions and government labs) that are working on perfecting the microbattery.

Our work with microbatteries is a subset of a broader work with AAO nanopore templates (which is used to create the nanowires) as well as nanoparticle coatings for flatter cathode materials. This is a market poised to explode and there are vast opportunities available.

Click on the link below for more information:

Contact Dr. Daniel Choi at the Masdar Institute for additional information: https://www.masdar.ac.ae/faculty-top/list-of-faculty/item/6235-daniel-choi