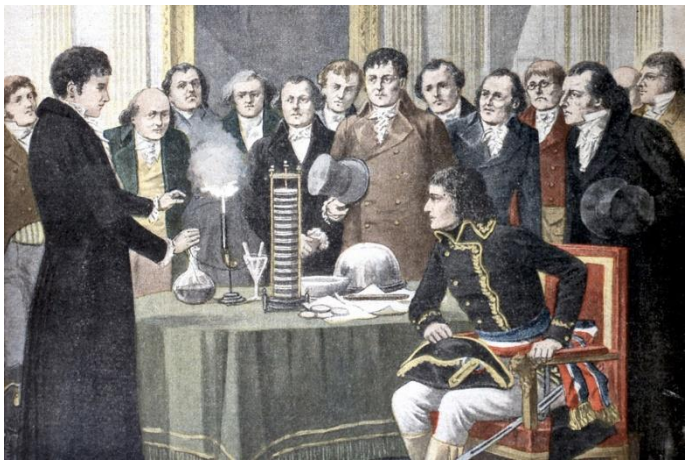
Battery Technologies & Silver

Batteries are currently one of the hottest topics in technology. This has been driven by the rapid growth in hybrid and electric vehicles, and the associated search for improved battery technologies with better efficiencies and economics. Dozens of Fortune 500 companies have moved into the space, most notably oil & gas giant BP who has predicted that buying, running and powering electric cars in Europe will become competitive with Internal Combustion Engine (ICE)-driven models before 2050. The company is working on developing technologies associated with new battery materials and fast-charging, and silver will continue to play a role in this evolution.

Like many technologies, batteries have a fascinating history. Alessandro Volta is generally agreed to have invented the first practical battery in the early 1800s, which came to be known as the Voltaic Pile. This was a simple stack of metal discs separated by a cloth soaked in brine. After experimenting with a variety of different metals, Volta discovered that zinc and silver provided the most effective combination. The next two centuries saw dozens of developments in the field from scientists all over the world, with different combinations of metals leading to a range of new battery functionalities (for example, dry cells and rechargeability).



It was reported that Volta 'amazed' Napoleon with his silver-zinc battery (Universal Images Group / Getty Images)

Batteries are, in reality, very simple pieces of engineering. They all contain three key components – two electrodes and an electrolyte material. In the Voltaic Pile, the electrodes were silver and zinc, with the brine acting as the electrolyte. The critical part of any battery is that the two electrodes are *different*. Chemically, a battery relies on one electrode being able to release electrons whilst the second is able to accept those electrons. This circuit is driven by chemical reactions within the electrolyte material, and the combination of the three components dictates the various functionalities and efficiencies of the battery itself.

Volta didn't understand why at the time of his discovery, but the reason he identified silver-zinc as one of the best electrode combinations is that these two metals offer more energy per ounce than any other battery pairing. However, as the years passed, and more efforts were made to capture this high energy density, a major problem was discovered; the metals were soluble and deteriorated in the relatively aggressive conditions of the battery cell, severely impacting efficiency. As has so often

been the case, it was research performed by the US military in World War II which provided a solution to this issue; a membrane was developed to separate the electrodes.

The high energy density of these now more reliable batteries attracted interest from a range of industries, particularly military and aerospace. Both sectors utilized silver-zinc in a range of applications and undertook a considerable amount of R&D to further develop the technology, with the US National Aeronautics and Space Administration (NASA) becoming increasingly involved in the development of a rechargeable version of silver-zinc. While NASA was ultimately not able to improve on the most commonly used rechargeable nickel-cadmium technology at the time, their R&D efforts led to high density silver-zinc cells, 1/3 of the size of anything else available.

Fast forward to the present day, and the market for single-use silver oxide button cell batteries in devices such as quartz watches is considerable. Major manufacturers include Sony and Renata, and hundreds of millions of units are sold annually. However, many devices now contain integrated power sources which require rechargeability, with alkaline and lithium-ion based technologies dominating these markets given their relatively low costs. These technologies carry some disadvantages, however, including being prone to leakage and, in rare cases, thermal runaway, which can cause lithium-ion batteries to catch fire. Consequently, safety considerations, size and energy density advantages have seen rechargeable silver-zinc begin to find traction in several specific markets. California-based company ZPower has been at the forefront of these developments, matching the small, energy dense batteries with the fast-evolving wearables sector. Over the last few years ZPower has targeted the hearing aid market, which demands reliable, safe and small rechargeable batteries. The business operates 4 production lines in the USA, running 7 days a week and producing over 5 million batteries annually.

California-based ZPower produce 5 million silver-zinc batteries annually (Courtesy of ZPower)

According to ZPower's President and Chief Executive Officer Dr. Ross Dueber, the growing market for wearable technologies is going to create considerable demand for silver-zinc batteries. One of the company's most recent collaborations was with Bose, who have just released wireless noise-masking earbuds which are powered by ZPower's silver-zinc batteries. "Our success with hearing aids and Bose is just the beginning," Dr. Dueber said. "We are capitalizing on this momentum to establish silver-zinc batteries as a preferred power source for the growing number of electronic devices that require smaller, safer and more energy dense solutions."

Offtake for silver in these batteries is currently comparatively small, with ZPower using limited amounts of the metal annually. However, the potential for considerable growth is significant with wearable technologies becoming increasingly embedded in everyday life. But above all other

considerations, this silver-based technology is providing thousands of hearing-impaired individuals with a safe, reliable, rechargeable battery.