A History of Creativity: Battery Development for Implantable Medical Devices

Esther Sans Takeuchi and
Randolph A. Leising

Wilson Greatbatch Technologies Inc.
10,000 Wehrle Drive, Clarence, NY 14031

The history of development of batteries used to power implantable medical devices contains numerous examples of the creative process at work; from early development of a battery for the implantable pacemaker to new avenues for powering artificial hearts. In many cases the power sources developed for these medical applications were the enabling technologies for new life-saving devices.

The first experimental pacemakers were implanted in animals over forty years ago using zinc/mercury cells first developed during World War II.[1] These Ruben Mallory Zn/Hg cells powered nearly all of the early implantable pacemakers. Although they made pacemakers possible, the device lifetime was typically limited to less than two years. Much work was conducted to look for a replacement power source, including rechargeable, nuclear and biological batteries. Lithium iodine batteries were introduced for use in implantable pacemakers in 1971, and became the standard for this device. The use of the Li/I_2 battery provided the advantage of long life, high reliability and hermaticity.

The first implantable cardioverter-defibrillators (ICDs) were developed in the mid-1970's to detect and provide therapy for a range of ventricular tachyarrhythmias.[2] The thrust of this therapy is to provide a shock directly to the patient's heart, stopping ventricular fibrillation. Thus, the power source for this application must be able to provide very high current pulses on demand, in addition to meeting other special requirements for the implantable device. Development of lithium/silver vanadium oxide batteries for this application led to the successful commercialization of this life-saving device and ~ 100,000 ICDs were implanted worldwide this past year.

Many new implantable medical devices are currently under development. These include neurostimulators to treat diseases such as Parkinson's disease and epilepsy, implantable hearing devices to treat hearing loss which can not be treated by conventional hearing aids, and devices to assist the heart in pumping blood (LVADs) or replace the heart entirely (artificial hearts).[3] These new devices all have specific requirements which require new power source solutions. These include advanced rechargeable battery chemistries to enable high power output over many years of service for the implanted device.

References

1) W. Greatbatch, *The Making of The Pacemaker*, Prometheus Books, Amherst, New York (2000).
2) E. S. Takeuchi, *Proc. of Batt. Conf. on Appl. & Advances*, Long Beach, CA, (1991).
3) C. F. Holmes, R. A. Leising, D. M. Spillman, E. S. Takeuchi, *ITE Battery Letters*, 1 (1999) 132-134.