Portable Power at the Heart of Defibrillators

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Implantable cardioverter defibrillators (ICDs) save thousands of lives annually for patients with weak or damaged hearts who are at heightened risk of sudden cardiac arrest. The ICD is battery-powered, and when the battery's charge depletes, it must be replaced. How long can the battery be expected to last? The answer depends on the type of battery used. This article will evaluate the critical design characteristics of ICD batteries.

Of the many battery chemistries available today, only a few are suitable for being implanted in the human body. Some simply lack the longevity demanded by the application, or in order to fulfill the power requirements, would need to be too large to fit the rather compact space available. And some others that do satisfy these needs are simply too toxic, containing poisonous materials that prohibit their use.

Given the need for a battery that is both safe and long-lasting, Lithium/Carbon Fluoride has emerged as the most popular type for medical implants. These batteries have a relatively high volumetric energy density, enabling them to pack sufficient power in a small space. And although the manufacturing process is not without its share of environmental concerns, the battery itself is as benign as it is dependable.

Nano technology and other advancements have made some significant improvements in the performance of today's Advanced Lithium/Carbon Fluoride batteries. Before examining those, however, it is beneficial to understand the two basic functions of an ICD from the battery's perspective. The first function involves sensing when the heart is experiencing an abnormal rhythm. This requires a sustained but relatively low amount of current. The second function is to deliver a shock to the heart when necessary to restore a normal rhythm, and this requires a short but considerably higher pulse (no pun intended) current.

The performance advantage of the Advanced Carbon Fluoride battery derives from the ability to customize or tune its cathode to meet the specific requirements of both ICD functions. By altering how fluorine is introduced into the carbon structure at the atomic level during the manufacturing process, the battery's fundamental properties are altered to achieve the optimal balance of energy and power densities. This enables the Advanced Carbon Fluoride battery to enjoy a substantially longer service life as it continuously monitors cardiac rhythms and periodically delivers its life-saving shock.

The customized cathode nearly doubles the volumetric energy density compared to Lithium/Manganese Dioxide, another popular battery chemistry used in certain medical applications. Specifically, Advanced Carbon Fluoride batteries have a volumetric energy density of 700 to 1000 Watt-hours per liter (Wh/l) compared to Manganese Dioxide's typical 500-650 Wh/l in the form factors commonly used in medical implants. Although less important in ICDs, Advanced Carbon Fluoride batteries enjoy a higher gravimetric energy density of over 600 Watt-hours per kilogram (Wh/kg) compared to Manganese Dioxide's typical 200-250 Wh/kg.

Advanced Carbon Fluoride batteries can also be customized in other ways to meet the specific needs of the ICD manufacturer. Support for cylindrical, thin film and prismatic form factors, for example, allows the battery pack to be tailored to precisely fit the design of the ICD itself.

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About the Author

Joe Carcone is VP of Sales and Marketing at Contour Energy Systems. Carcone started his career with Bell Labs in engineering for terrestrial and aerospace battery systems. At GE, he worked in the rechargeable battery business. For over 20 years, Carcone was responsible for sales and marketing for North and South American Operations with SANYO Energy USA, and most recently with PowerGenix, a venture start-up company specializing in nickel zinc rechargeable batteries. Carcone holds a BS in electrical engineering and an MS in operations research from Rutgers University.