Advances in Rechargeable Battery Technologies
A Tutorial

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Applications sectors such as consumer and light industrial electronics, medical electronics, power back-up and conditioning, motive power, etc., are driving battery research in diverse directions. This tutorial examines advanced research on materials, battery chemistries, manufacturing, and applications intended to meet a variety of operational requirements. Some of the requirements include shelf-life, cycle-life, storage-life, high- or low-temperature operation or storage, high reliability and safety, and high-power. Often these requirements have divergent needs for materials and designs. Recent work and challenges in prominent aqueous and non-aqueous chemistries will be discussed.

Some of the specific areas discussed:

Electrolytes for low temperature lithium-ion cells: These electrolytes are not only designed to enhance low temperature operation, but also to enhance safety and minimize the possibility of plating metallic lithium.

High-temperature stability of lithium-ion cells: This is a complex issue with reactivity of solvents, salts, anode and cathode materials as a function of temperature, potential and state-of-charge.

Ionic liquids, also known as molten salts: Ionic liquids have experienced a resurgence of interest as electrolytes for ambient temperature batteries and capacitors. This is largely because new materials have been found that are less corrosive than $AlCl_3$-based electrolytes, which was the focus of work for many years. In addition, these new electrolytes contain the lithium or sodium ions necessary to run lithium or sodium cells [1].

Low-voltage lithium-ion cells: A reincarnation of the intercalation chemistry designed to serve lower voltage applications and requiring less expensive electrolytes because of the lower voltages involved [2].

Advances in polymer electrolytes, polymer batteries and scale-up issues for lithium-ion batteries will also be discussed.

Developments in other battery chemistries such as nickel-metal hydride, nickel-zinc, and lead-acid will be discussed, as will hybridization systems incorporating batteries.

1. G.E. Blomgren and A. Webber in “Advances in Lithium Ion Batteries,” B.Scrosati and W. van Schalkwijk, eds., Kluwer Academic Publishers, Amsterdam, 2002
2. Bruno Scrosati, ibid.