

ADVANCED SECONDARY BATTERY DEVELOPMENT AND TESTING. A CANADIAN PERSPECTIVE

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Introduction

Advanced secondary battery development in Canada is principally centered around both lithium and sodium systems. Lithium systems development activities have been conducted by numerous investigators. Ballard Research, Moli Energy, and Electrofuel Mfg. Co. are among those who have made significant contributions in this area. The recent joint venture between Swiss-controlled Brown, Boveri & Cie of Mannheim, West Germany, and Magna International Inc. of Markham, Ontario has resulted in intense activity in the sodium-sulphur area.

Lithium systems

Ballard Research, located in the Vancouver area, is well known for its capabilities in the manufacturing technology of non-rechargeable lithium-sulphur dioxide cells. More recently, this work has been extended to include rechargeable cells ranging from 0.8 A h to 6.2 A h capacities. Capacities and life cycle rating parameters for these cells are shown below:

Organization:	Ballard Research Inc.			
Battery/cell type:	Rechargeable lithium/sulphur dioxide			
Battery/cell size C ₃ (A h)	0.8	1.8	2.9	6.2
Nominal open circuit voltage	2.9	2.9	2.9	2.9
Type of discharge	Const. <i>I</i>	Const. <i>I</i>	Const. <i>I</i>	Const. <i>I</i>
Discharge rate (<i>I_x</i> , <i>x</i>)	0.27, 3	0.6, 3	0.97, 3	2.07, 3
Depth of discharge	n/a	n/a	n/a	n/a
Charge rate (<i>I_x</i> , <i>x</i>)	0.08, 10	0.18, 10	0.29, 10	0.62, 10
End of life criteria	n/a	n/a	n/a	n/a

During the past two years, Moli Energy, also of Vancouver, has developed rechargeable Li/MoS₂ batteries in both AA and C sizes. More recently, the 65 A h "BC" size has undergone successful initial testing. Potential uses including traction applications, and remote power are being considered. For the present, however, Moli considers consumer products, especially portable electronic devices, to be the big growth market. Capacities and life-cycle rating parameters for these cells and batteries are shown below:

Organization:	Moli Energy Ltd.		
Battery/cell type:	Lithium/molybdenum disulfide		
Battery/cell size C ₅ (A h)	0.6	2.0	65
Nominal open circuit voltage	1.8	1.8	1.8, 10.8*
Type of discharge	Const. I	Const. I	Const. I
Discharge rate (I_x , x)	0.12, 5	0.84, 2.38	15, 4.3
Depth of discharge	100%	100%	100%
Charge rate (I_x , x)	0.06, 10	0.28, 7.2	5, 13
End of life criteria	50% of nominal capacity	80% of nominal capacity	50% of nominal capacity

*A 6 cell battery having a nominal voltage of 10.8 V has been tested for over 100 cycles.
n/a — not available.

Electrofuel Manufacturing Co., located in Toronto, launching off earlier work done at Argonne, has been conducting development work on LiAl/FeS high temperature cells. The company is concentrating on cells of about 150 A h with an EV battery as a 1986/1987 goal. Work to date has resulted in a significant reduction in the cost associated with production of the boron nitride felt separator. The parameters associated with this cell are shown below:

Organization	Electrofuel Manufacturing Co.
Battery/cell type:	Lithium aluminum/iron sulfide
Battery/cell size C ₄ (A h)	150
Nominal open circuit voltage	1.35
Type of discharge	Const. I
Discharge rate (I_x , x)	30, 4
Depth of discharge	80 - 85%
Charge rate (I_x , x)	30, 4
End of life criteria	90% efficiency

Sodium-sulphur systems

Powerplex Technologies Inc., the BBC-Magna joint venture company was established late in 1984. Using the BBC technology, Powerplex will develop, manufacture, and sell high energy sodium-sulphur batteries and electric vehicle drive systems in North America.

Presently, Powerplex occupies a 13 500 ft.² facility in Downsview, Ontario. A staff of fifteen (15), including eight (8) scientific/engineering/manufacturing personnel have initiated development programs in the areas of ceramic electrolytes, sulphur electrode corrosion resistant coatings, thermal enclosures, cell and battery test methods, and electric vehicle conversions.



Fig. 1. Cell and module test facility.

Cell and module test capability has been established (see Fig. 1). Testing began in June, 1985. The capacity of the test facility will be expanded in September, 1985, to allow the testing of 27 kW h batteries.

Delivery of equipment and tooling to support cell and battery prototype manufacturing is underway. Prototype component fabrication will start in August, 1985, with prototype cell and battery assembly to begin before the end of 1985.

Electric vehicle conversions have been initiated at Powerplex based on an initial BBC conversion concept. In March, the Ontario Center for Automotive Parts Technology awarded Powerplex a contract to convert two Chrysler T-115 vans to electric power. These conversions are now complete (see Fig. 2).



Fig. 2. Electric vehicle, Chrysler T-115 van.

The batteries and cells undergoing development at Powerplex are identified in the chart below:

Organization:	Powerplex Technologies Inc.	
Battery/cell type:	Sodium/sulphur	
Battery/cell size C_2 (A h)	38	118*
Nominal open circuit voltage	2.08	112
Type of discharge	Const. I	Const. I
Discharge rate (I_x, x)	16, 2.375	64, 1.8
Depth of discharge	100%	100%
Charge rate (I_x, x)	8, 4.75	32, 3.7
End of life criteria	n/a	n/a

*Battery has been tested in vehicle applications by BBC.

Conclusion

Advanced secondary battery development programs in Canada have been centered principally around the lithium and sodium systems. Cells and/or batteries having EV capability have been tested with exciting results. Electric vehicle conversions using the latest state of the art microprocessor-controlled powertrains have also been demonstrated. These encouraging results have served to reinforce the determination and commitment of this small group of professionals. We are confident that Canada will continue to play a key role in the development of advanced energy systems in the future.