Charging Processes of Microscopic Ni/Zn Batteries

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Introduction

Rechargeable microscopic batteries are contemplated as part of a power supply for remote autonomous sensors, particularly those utilizing MEMS technology. Batteries are needed which can store small amounts of energy, sufficient to power the sensor for a period without energy input from the environment. The batteries are ideally integrable with the electronics.

The batteries must provide short high power pulses during communication (such as RF activity) (1). The discharge characteristics of microscopic Ni/Zn batteries have been reported (2), Charging behavior has received less attention. The charging of microscopic batteries is important as well, as most charging sources (photovoltaic, RF, etc.) deliver energy intermittently, and at variable power levels. A microscopic battery must ideally be able to absorb energy at high power levels, at least for short times. Conversely, any charge control circuit must be able to tune the charging current to a battery with sufficient response time, so as to protect the battery. We report experimental results of charging of microscopic Ñi/Zn batteries, for coupling with our fuzzy-logic based charge control circuit (3).

Experimental

Microscopic Ni/Zn batteries were made at Brigham Young University using microfabrication processes as previously described (2). Batteries were made in a coplanar geometry (see Figure 1). The area of a single cell was 0.036 cm^2 (6 mm X 0.6 mm). Cells were made on a four inch Si wafer, in banks of six cells, as shown in.Figure 2. A PAR 273 potentionstat/ galvanostat was used to control the charging and discharge of batteries. Batteries were subjected to both galvanostatic and potentiostatic charges. Results shown were from banks of six parallel-connected cells at ambient temperature. Nominal capacity of was 0.083 mA•hr (see Figure 3).

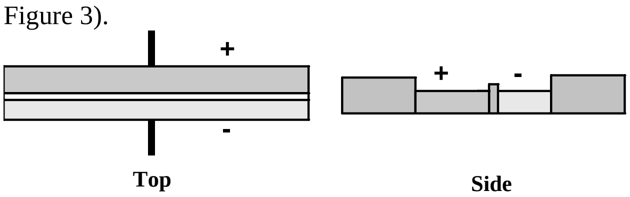

Figure 1. Schematic Drawings of Ni/Zn Cells.

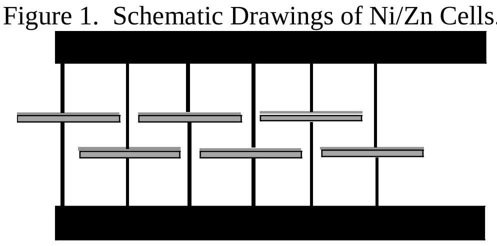

Figure 2. Bank of Six Cells on Si Wafer.

Results

Figure 3 shows a charge at 1.9 V (considered maximum allowable potential). The cell could accept > 2 mA at this potential for approximately 0.8 seconds. The state of charge is a significant determinant of allowable charging rate, as is common with other Ni/Zn batteries, (see Figure 5). It is apparent that cells that are near full charged, must be protected by circuits that can respond in < 1 second, to maximize battery life. It also appears that despite the coplanar geometry, transient high charging rates (> 20C) can be sustained.

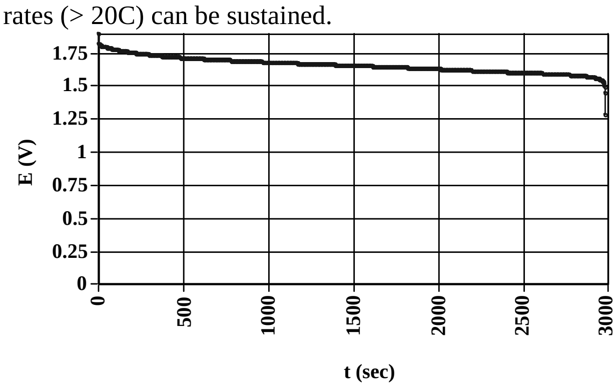

Figure 3. Discharge (0.1 mA) of a Six-Cell Bank.

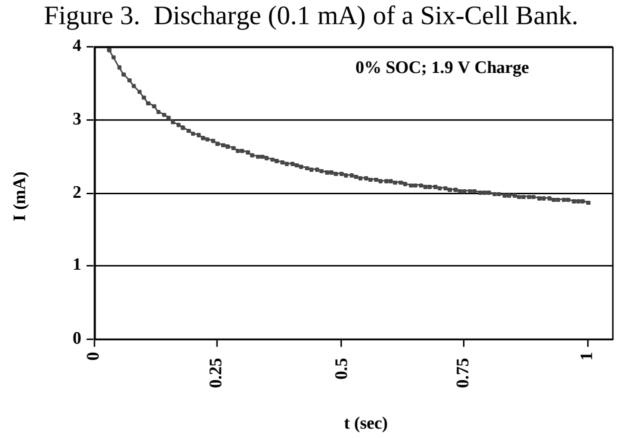

Figure 4. Potentiostatic (1.9V) Charge, 0% SOC.

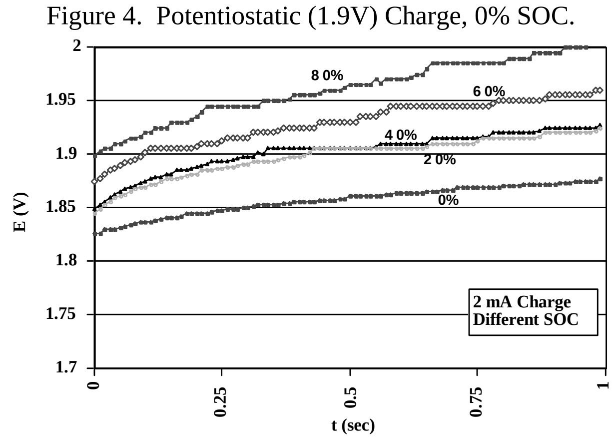

Figure 5. Galvanostatic Charge (2 mA), Different SOC.

Acknowledgements

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