Single-particle Microbatteries

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Efforts are being devoted in our laboratory toward developing methods for the assembly and characterization of single particle microbatteries, both in aqueous and non-aqueous electrolytes. Of particular interest is to examine the intrinsic properties of single microparticle materials used in actual devices in a battery type arrangement and identify the factors that control their performance using *in-situ* optical and/or spectroscopic probes in addition to conventional electrochemical techniques.

Single particle microbatteries incorporate metal microdisk electrodes which serve both as mechanical supports and current collectors for single particles of cathode and anode materials. Shown in Fig.1 is a micrograph of a metal hydride (MeH) – Ni oxide (NiOOH) microbattery using Au microelectrodes. Charge-discharge curves recorded for this microbattery at ~40 nA were found to be similar to those of conventional MeH/NiOOH (Fig.2.). A behavior typical of a conventional battery involving the same chemistry was also found in discharge curves for Zn-MnO_2 alkaline primary microbatteries (not shown here).

More recently, techniques have been developed to allow the assembly of Li-ion batteries involving microparticles of MCMB (anode) and $LiMn_2O_4$ (cathode). A micrograph and schematic diagram of such a battery are shown in Figs. 3 and 4, respectively. Individual charging curves recorded for MCMB and $LiMn_2O_4$ single particles performed in this configuration by potential sweep method are presented in Fig.5.

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REFERENCES

1. A. Palencsár and D.A. Scherson, *Electrochem. Solid State Letters*, **6**, E1-E4, (2003)
2. K. Dokko, Q.F. Shi, I.C. Stefan, D.A. Scherson, *J.Phys. Chem. B* 107 (46): 12549-12554 (2003)
3. Q.F. Shi, K. Dokko, D.A. Scherson, *J.Phys. Chem. B* 108 (15): 4789-4793 (2004)
4. For other work in this and other related areas see: a. I. Uchida, H. Fujiyoshi, and S. Waki, *J. Power Sources*, **68**, 139, (1997); b. T. Hamelmann and M.M. Lohrengel, *Electrochim. Acta*, **47,** 117 (2001)

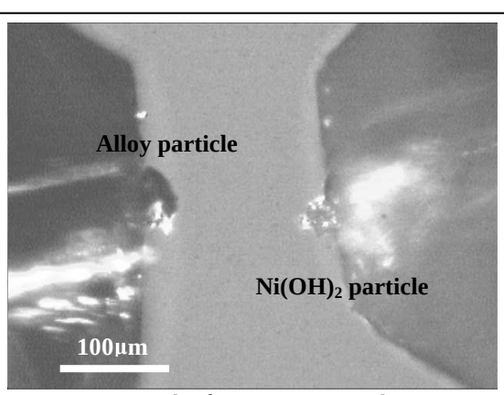

Fig.1. Micrograph of a Ni-MeH microbattery

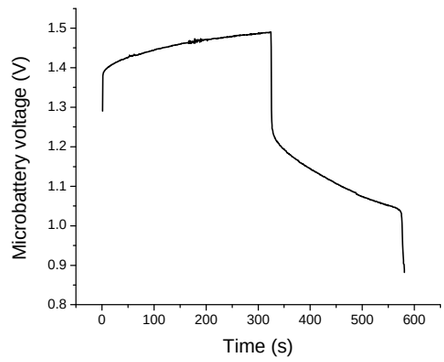

Fig.2. Galvanostatic charge-discharge curve for a Ni-MeH single particle microbattery at a rate of ca. 40nA

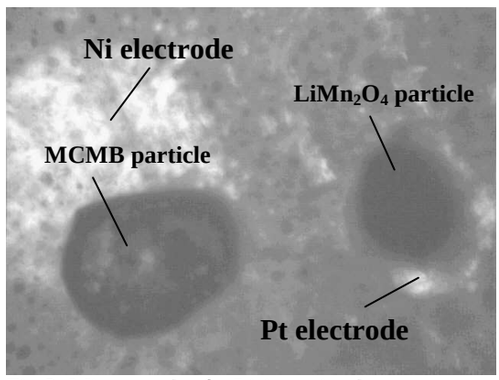

Fig.3. Micrograph of a Li-ion microbattery

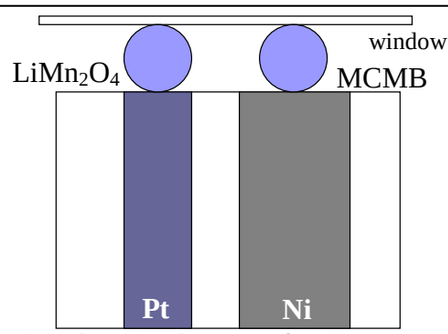

Fig.4. Schematic diagram of a Li-ion single particle microbattery

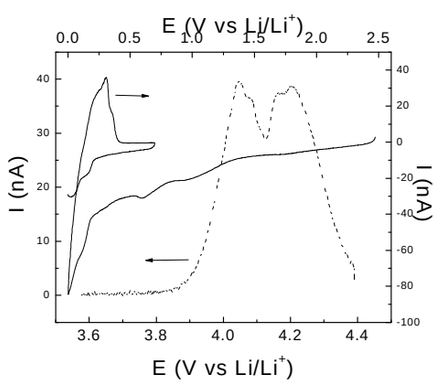

Fig.4. Individual charging curves recorded for MCMB and $LiMn_2O_4$ single particles by potential sweep