

5

% were kept constant at a ratio of 10% to 90%, respectively. This was then mixed with ethylene carbonate dissolved in dimethyl carbonate to prepare a solution that contained 0%, 25% 50% and 75% wt % of ethylene carbonate to PVDF+ graphite. In some cases a small quantity of surfactant was added to stabilize the ink. A wt % solids loading of approximately 5% was used for inkjet printed samples. A wt % solids loading of approximately 20 wt % solids loading for doctor bladed samples.

Electrodes were prepared by doctor blading the ink on copper current collectors. The electrode mass was determined by weighing and then assembled in a coin cell without further processing. A solid lithium metal electrode was used as the counter electrode in the coin cell. Just prior to sealing the cell additional electrolyte was added comprising LiPF₆ dissolved in an alkyl carbonate solvent. The cells were then tested for Coulombic capacitance at various rapid discharge rates up to 4C until the cell voltage dropped to 5 mV. Discharge was then continued at a fixed cell potential of 5 mV until the current dropped below 5 mA per gram of graphite. As illustrated in FIG. 4, the sample prepared with 50% ethylene carbonate showed the highest Coulombic efficiencies for both the rapid and total capacitances. The rapid discharge capacitance depended upon the percent ethylene carbonate in the order of 75%<0%<25%<50%.

Shown in FIGS. 5(a) and 5(b) are scanning electron micrographs of samples prepared with 50% and 0% ethylene carbonate, respectively. The images show the enhanced porosity afforded by methods described herein. Also evident in FIG. 5(a) are the strands of PVDF between graphite flakes that help maintain the physical integrity of the electrode while obtaining high porosity. These strands are not found in conventionally prepared electrodes where NMP is used as the solvent for PVDF.

These results show that ethylene carbonate can be successfully used to form pores in mechanically stable films, that ethylene carbonate can disrupt the layered graphite structure resulting in reduced pore tortuosity, that ethylene carbonate is easily dissolved from the films without destroying the film structure, that the use of ethylene carbonate can enhance the binding effect of PVDF and may be used to manipulate the electrode structures, that the porosity formed by the ethylene carbonate can enable rapid discharge rates, and that the electrode structure does not require any post deposition processing prior to incorporation into the battery.

While a number of embodiments of the present invention have been shown and described, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the invention in its broader aspects. The appended claims, therefore, are intended to cover all such changes and modifications as they fall within the true spirit and scope of the invention.

We claim:

1. A method for preparing porous electrodes as contained in lithium-ion batteries that comprise an electrolyte composition, the method characterized by:

depositing on a substrate a feedstock comprising a soluble pore former, thereby initiating formation of an electrode;

precipitating at least a portion of the soluble pore former from the feedstock, thereby causing said portion of the soluble pore former to exist in a solid phase within the electrode; and

6

dissolving the pore former from the electrode using at least a portion or constituent of the electrolyte composition, thereby leaving voids that form pores in the electrodes.

2. The method of claim 1, wherein said precipitating comprises evaporating at least a portion of the feedstock.

3. The method of claim 1, wherein said precipitating comprises altering the temperature of the feedstock.

4. The method of claim 1, wherein the soluble pore former forms a two-phase system with at least one constituent of the electrolyte composition.

5. The method of claim 1, wherein the soluble pore former comprises ethylene carbonate.

6. The method of claim 5, wherein the feedstock further comprises dimethyl carbonate, diethyl carbonate, propylene carbonate, or combinations thereof.

7. The method of claim 1, wherein the feedstock does not contain a sacrificial pore former.

8. The method of claim 7, wherein the feedstock does not contain N-methyl-2-pyrrolidone (NMP) or dibutylphthalate (DBP) as the sacrificial pore former.

9. The method of claim 1, wherein the electrolyte composition comprises dimethyl carbonate, diethyl carbonate, or combinations thereof.

10. The method of claim 1, wherein the feedstock does not contain materials that are not also substantially contained in the lithium-ion battery.

11. The method of claim 1, wherein the feedstock is an ink for ink jet printing and said forming comprises printing with an ink jet printer.

12. A method for preparing porous electrodes as contained in lithium-ion batteries that comprise an electrolyte composition, the method characterized by:

depositing on a substrate a feedstock comprising a soluble pore former, thereby initiating formation of an electrode;

evaporating at least a portion of the feedstock, thereby precipitating at least a portion of the soluble pore former from the feedstock and causing said portion of the soluble pore former to exist in a solid phase within the electrode; and

dissolving the pore former from the electrode using at least a portion or constituent of the electrolyte composition, the soluble pore former forming a two-phase system with at least one constituent of the electrolyte composition, thereby leaving voids that form pores in the electrodes.

13. A method for preparing porous electrodes as contained in lithium-ion batteries that comprise an electrolyte composition, the method characterized by:

depositing on a substrate a feedstock comprising a soluble pore former, thereby initiating formation of an electrode;

altering the temperature of the feedstock, thereby precipitating at least a portion of the soluble pore former from the feedstock and causing said portion of the soluble pore former to exist in a solid phase within the electrode; and

dissolving the pore former from the electrode using at least a portion or constituent of the electrolyte composition, the soluble pore former forming a two-phase system with at least one constituent of the electrolyte composition, thereby leaving voids that form pores in the electrodes.

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