



(51) International Patent Classification:

H01M 10/0567 (2010.01) *H01M 10/05* (2010.01)
H01M 10/052 (2010.01) *H01M 6/16* (2006.01)

(21) International Application Number:

PCT/EP2013/066940

(22) International Filing Date:

13 August 2013 (13.08.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12180467.8 14 August 2012 (14.08.2012) EP

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

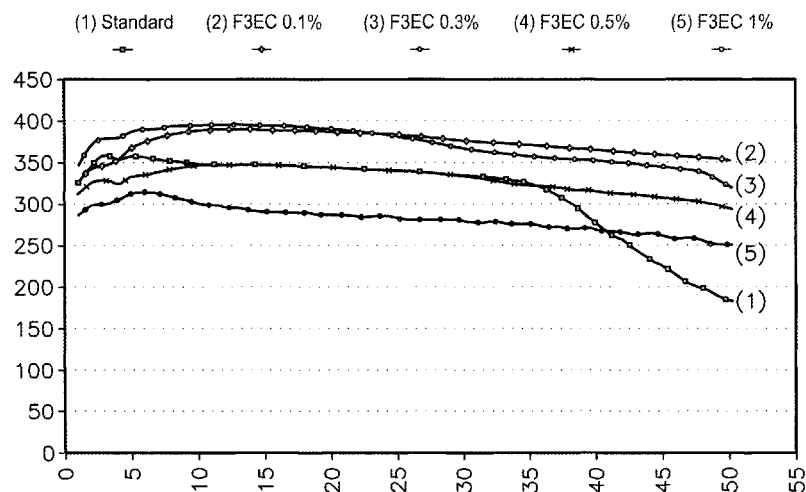
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: USE OF LOW CONCENTRATIONS OF FLUORINATED ORGANIC COMPOUNDS AS SOLVENT ADDITIVES

Fig. 1



(57) Abstract: The invention concerns the use of low concentrations of fluorinated organic compounds, e.g. fluorinated derivatives of 1,3-dioxolan-2-one, as solvent additives in Li ion batteries, Li air batteries or Li sulfur batteries.

Use of low concentrations of fluorinated organic compounds as solvent additives

This application claims priority to European patent application No. 12180467.8 filed on the 14th August 2012, the whole content of this application being incorporated herein by reference for all purposes.

The invention concerns the use of low concentrations of fluorinated
5 organic compounds, e.g. fluorinated derivatives of 1,3-dioxolan-2-one, as solvent additives in Li ion batteries, Li air batteries or Li sulfur batteries.

Li ion batteries, Li air batteries and Li sulfur batteries are well-known rechargeable means for storing electric energy. The advantage of this type of batteries is, for example, a high energy density, and that they have no memory
10 effect.

Li ion batteries comprise an anode, a cathode and an electrolyte composition containing a solvent, a conductive salt and often one or more solvent additives. The solvent is an aprotic organic solvent which serves to dissolve the conductive salt. Suitable conducting salts are known in the art.
15 LiPF₆ is the preferred conducting salt. Other conducting salts are also suitable as constituent of the electrolyte solutions of the present invention, for example, e.g. Li bisoxalatoborate (LiBOB), Li bis(fluorosulfonyl)imide (LiFSI), Li bis(trifluorsulfonyl)imide (LiTFSI) or LiBF₄.

Solvent additives improve the properties of the Li ion batteries. For
20 example, fluorinated organic compounds, e.g. fluorinated cyclic carbonates, are applicable as solvent additives.

It is an objective of the present invention to provide an improved method of use of the fluorinated organic compounds used as solvent additives. Another objective is to provide improved solvent compositions and electrolyte
25 compositions, in particular for Li ion batteries, Li air batteries, Li sulphur batteries. It has now been surprisingly found that the use of a low concentration of fluorinated organic compound as additive solves these and other objectives.

Thus, the method of use as described in the present invention provides advantages like modifying the viscosity or reducing the flammability of the
30 solvent and/or electrolyte compositions. Another advantage is an improved charge-discharge cycle. Yet another advantage is an improved initial discharge

- 2 -

capacity.

Another advantage is an improved modification of the electrodes under formation of beneficial films. A further advantage is the possible formation of a dense and stable SEI (Solid Electrolyte Interface) on a surface within the battery, for example on the surface of the negative electrode. Yet another advantage is the possible formation of an SEI having adequate thickness on a surface within the battery, for example on the surface of the negative electrode.

The present invention concerns the use of a fluorinated organic compound as a solvent additive for an electrolyte composition, in particular for Li ion batteries, Li air batteries or Li sulfur batteries wherein the concentration of the fluorinated organic compound is equal to or below 1 wt %, preferably equal to or below 0.75 wt %, more preferably equal to or below 0.5 wt % and most preferably equal to or below 0.3 wt % relative to the total weight of the electrolyte composition. Preferred compounds are monofluorinated, difluorinated, trifluorinated, or tetrafluorinated. Also preferred are fluorinated derivatives of cyclic or acyclic carbonates, more preferred are fluorinated derivatives of 1,3-dioxolan-2-one, especially preferred is 4,4,5-trifluoro-1,3-dioxolan-3-one (F3EC). In another preferred embodiment, the invention concerns the use of a fluorinated organic compound as a solvent additive for an electrolyte composition, in particular for Li ion batteries, Li air batteries or Li sulfur batteries in a concentration from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total weight of the electrolyte composition.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 : Cycle Performance with F3EC as additive [discharge capacity (mAh/g) / cycle number (n)]

Fig. 2 : Initial Performance with F3EC as additive [discharge capacity (mAh/g) / cycle number (n)]

The invention also provides a method of use of a fluorinated organic compound as a solvent additive for an electrolyte composition, in particular for Li ion batteries, Li air batteries or Li sulfur batteries in a concentration from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total weight of the electrolyte composition.

Preferably, the sum of the individual concentrations of all solvent additives present in the electrolyte is from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total

weight of the electrolyte composition.

The term "total electrolyte composition" denotes compositions containing at least one fluorinated organic compound of the invention, an electrolyte salt and a solvent suitable for Li ion batteries and optionally further solvent additives.

5 Fluorinated organic compounds useful as solvent additives are, for example, fluorinated carbonic esters which are selected from the group of fluorosubstituted ethylene carbonates, polyfluorosubstituted dimethyl carbonates, fluorosubstituted ethyl methyl carbonates, and fluorosubstituted diethyl carbonates are other solvents or, preferably, suitable additives or in the
10 electrolytic compositions. Preferred fluorosubstituted carbonates are monofluoroethylene carbonate, 4,4-difluoro ethylene carbonate, 4,5-difluoro ethylene carbonate, 4-fluoro-4-methyl ethylene carbonate, 4,5-difluoro-4-methyl ethylene carbonate, 4-fluoro-5-methyl ethylene carbonate, 4,4-difluoro-5-methyl ethylene carbonate, 4-(fluoromethyl)-ethylene carbonate, 4-(difluoromethyl)-
15 ethylene carbonate, 4-(trifluoromethyl)-ethylene carbonate, 4-(fluoromethyl)-4-fluoro ethylene carbonate, 4-(fluoromethyl)-5-fluoro ethylene carbonate, 4-fluoro-4,5-dimethyl ethylene carbonate, 4,5-difluoro-4,5-dimethyl ethylene carbonate, and 4,4-difluoro-5,5-dimethyl ethylene carbonate ; dimethyl carbonate derivatives including fluoromethyl methyl carbonate, difluoromethyl methyl
20 carbonate, trifluoromethyl methyl carbonate, bis(difluoro)methyl carbonate, and bis(trifluoro)methyl carbonate ; ethyl methyl carbonate derivatives including 2-fluoroethyl methyl carbonate, ethyl fluoromethyl carbonate, 2,2-difluoroethyl methyl carbonate, 2-fluoroethyl fluoromethyl carbonate, ethyl difluoromethyl carbonate, 2,2,2-trifluoroethyl methyl carbonate, 2,2-difluoroethyl fluoromethyl
25 carbonate, 2-fluoroethyl difluoromethyl carbonate, and ethyl trifluoromethyl carbonate ; and diethyl carbonate derivatives including ethyl (2-fluoroethyl) carbonate, ethyl (2,2-difluoroethyl) carbonate, bis(2-fluoroethyl) carbonate, ethyl (2,2,2-trifluoroethyl) carbonate, 2,2-difluoroethyl 2'-fluoroethyl carbonate, bis(2,2-difluoroethyl) carbonate, 2,2,2-trifluoroethyl 2'-fluoroethyl carbonate,
30 2,2,2-trifluoroethyl 2',2'-difluoroethyl carbonate, and bis(2,2,2-trifluoroethyl) carbonate, 4-fluoro-4-vinylethylene carbonate, 4-fluoro-5-vinylethylene carbonate, 4,4-difluoro-4-vinylethylene carbonate, 4,5-difluoro-4-vinylethylene carbonate, 4-fluoro-4,5-divinylethylene carbonate, 4,5-difluoro-4,5-divinylethylene carbonate, 4-fluoro-4-phenylethylene carbonate, 4-fluoro-5-
35 phenylethylene carbonate, 4,4-difluoro-5-phenylethylene carbonate, 4,5-difluoro-4-phenylethylene carbonate and 4,5-difluoro-4,5-diphenylethylene carbonate,

- 4 -

fluoromethyl phenyl carbonate, 2-fluoroethyl phenyl carbonate, 2,2-difluoroethyl phenyl carbonate and 2,2,2-trifluoroethyl phenyl carbonate, fluoromethyl vinyl carbonate, 2-fluoroethyl vinyl carbonate, 2,2-difluoroethyl vinyl carbonate and 2,2,2-trifluoroethyl vinyl carbonate, fluoromethyl allyl carbonate, 2-fluoroethyl allyl carbonate, 2,2-difluoroethyl allyl carbonate and 2,2,2-trifluoroethyl allyl carbonate.

Other suitable solvent additives useful in the electrolyte compositions according to the present invention are those described in WO2007/042471 selected from the group of aromatic compounds consisting of 1-acetoxy-2-fluorobenzene, 1-acetoxy-3-fluorobenzene, 1-acetoxy-4-fluorobenzene, 2-acetoxy-5-fluorobenzyl acetate, 4-acetyl-2,2-difluoro-1,3-benzodioxole, 6-acetyl-2,2,3,3-tetrafluorobenzo-1,4-dioxin, 1-acetyl-3-trifluoromethyl-5-phenylpyrazole, 1-acetyl-5-trifluoromethyl-3-phenylpyrazole, benzotrifluoride, benzoyltrifluoroacetone, 1-benzoyl-3-trifluoromethyl-5-methylpyrazole, 1-benzoyl-5-trifluoromethyl-3-methylpyrazole, 1-benzoyloxy-4-(2,2,2-trifluoroethoxy)benzene, 1-benzoyl-4-trifluoromethylbenzene, 1,4-bis(t-butoxy)tetrafluorobenzene, 2,2-bis(4-methylphenyl)hexafluoropropane, bis(pentafluorophenyl) carbonate, 1,4-bis(1,1,2,2-tetrafluoroethoxy)benzene, 2,4-bis(trifluoromethyl)benzaldehyde, 2,6-bis(trifluoromethyl)benzonitrile, difluoroacetophenone, 2,2-difluorobenzodioxole, 2,2-difluoro-1,3-benzodioxole-4-carbaldehyde, 1-[4-(difluoromethoxy)phenyl]ethanone, 3-(3,5-difluorophenyl)-1-propene, fluorobenzophenone, difluorobenzophenone, 1-(2'-fluoro[1,1'-biphenyl]-4-yl)propan-1-one, 6-fluoro-3,4-dihydro-2H-1-benzothien-4-one, 4-fluorodiphenyl ether, 5-fluoro-1-indanone, 1-(3-fluoro-4-methoxyphenyl)ethanone, fluorophenylacetonitrile, the group of compounds having an Si-C bond consisting of bis(pentafluorophenyl)dimethylsilane, 1,2-bis[difluoro(methyl)silyl]ethane, N,O-bis(trimethylsilyl)trifluoroacetamide, N-(t-butyl)dimethylsilyl-N-methyltrifluoroacetamide, t-butyl)dimethylsilyl trifluoromethanesulphonate, 2-dimethylamino-1,3-dimethylimidazolium trimethyldifluorosilicate, diphenyldifluorosilane, the group of compounds having a C=O bond consisting of bis(1,1,1,3,3,3-hexafluoroprop-2-yl) 2-methylenesuccinate,

- 5 -

- bis(1,1,1,3,3,3-hexafluoroprop-2-yl) maleate, bis(2,2,2-trifluoroethyl) maleate, bis(perfluorooctyl) fumarate, bis(perfluoroisopropyl) ketone, 2,6-bis(2,2,2-trifluoroacetyl)cyclohexanone, butyl 2,2-difluoroacetate, cyclopropyl 4-fluorophenyl ketone, diethyl perfluoroadipate,
- 5 N,N-diethyl-2,3,3,3-tetrafluoropropionamide, the group of compounds having a C=C bond consisting of allyl 1H,1H-heptafluorobutyl ether, trans-1,2-bis(perfluorohexyl)ethylene, (E)-5,6-difluoroocta-3,7-diene-2-one, the group of amines consisting of
- 10 N,N-diethyl-1,1,2,3,3,3-hexafluoropropylamine
- Preferred fluorinated organic compounds useful as solvent additives in the electrolyte compositions are also selected from the group of fluorosubstituted carboxylic acid esters, fluorosubstituted carboxylic acid amides, fluorosubstituted fluorinated ethers, fluorosubstituted carbamates,
- 15 fluorosubstituted cyclic carbonates, fluorosubstituted acyclic carbonates, fluorosubstituted phosphites, fluorosubstituted phosphoranes, fluorosubstituted phosphoric acid esters, fluorosubstituted phosphonic acid esters and saturated or unsaturated fluorosubstituted heterocycles.
- Suitable fluorinated ethers applicable as solvent additives in the electrolyte
- 20 compositions are for example those as described in US 5,916,708, namely partially fluorinated ethers of formula (A)
- $$\text{RO}-[(\text{CH}_2)_m\text{O}]_n-\text{CF}_2-\text{CFH}-\text{X} \quad (\text{A})$$
- wherein
- R is a linear alkyl group with 1 to 10 C atoms or a branched alkyl group with 3
- 25 to 10 C atoms,
- X is fluorine, chlorine or a perfluoroalkyl group with 1 to 6 C atoms which groups may include ether oxygen,
- m is an integer of 2 to 6 and
- n is an integer of 1 to 8,
- 30 and/or of formula (II)
- $$\text{X}-\text{CFH}-\text{CF}_2\text{O}-[(\text{CH}_2)_m\text{O}]_n-\text{CF}_2-\text{CFH}-\text{X} \quad (\text{II})$$
- wherein
- X, m and n have the meaning given above.
- Partially fluorinated carbamates suitable as solvent additives are for
- 35 example those described in US 6,159,640, namely compounds of the formula $\text{R}^1\text{R}^2\text{N}-\text{C}(\text{O})\text{OR}^3$ wherein R^1 and R^2 independently are the same or

- 6 -

different, and are linear C1-C6-alkyl, branched C3-C6-alkyl, C3-C7-cycloalkyl, or R^1 and R^2 are connected directly or via one or more additional N and/or O atoms forming a ring with 3 to 7 members. Optionally, additional N atoms in the ring are saturated with C1 to C3 alkyl groups, and additionally, the carbon atoms of the ring may be substituted by C1 to C3 alkyl groups. In the groups R^1 and R^2 , one or more hydrogen atoms may be substituted by fluorine atoms. R^3 is a partially fluorinated or perfluorinated linear or branched alkyl group with 1 to 6 or, respectively, 3 to 6 carbon atoms, or a partially or perfluorinated cycloalkyl group with 3 to 7 C atoms, which may be substituted by one or more C1 to C6 alkyl groups.

Fluorinated acetamides suitable as solvent additive are for example those described US 6,489,064, namely partially fluorinated amide corresponding to formula $R^1CO-NR^2R^3$ wherein R^1 is a linear C1 - C6 alkyl group in which at least one hydrogen atom is replaced by fluorine, or a branched C3 - C6 alkyl group in which at least one hydrogen atom is replaced by fluorine, or a C3 - C7 cycloalkyl group optionally substituted one or more times by a linear C1 - C6 alkyl group or branched C3 - C6 alkyl group or both in which at least one hydrogen atom of the cycloalkyl group or the optional linear or branched alkyl substituent or both is replaced by fluorine, and R^2 and R^3 independently represent an identical or different linear C1 - C6 alkyl group, a branched C3 - C6 alkyl group or a C3 - C7 cycloalkyl group, or together with the amide nitrogen form a saturated five or six-membered nitrogen-containing ring, or are joined with one or more additional N and/or O atom(s) to form a 4 to 7-membered ring in which the additional N atoms present in the ring are optionally saturated with C1 - C3 alkyl groups and the ring carbon atoms may also carry C1 - C3 alkyl groups.

Partially fluorinated esters suitable as solvent additives are for example those described in US 6,677,085 partially fluorinated compound derived from a diol corresponding to the formula $R^1CO-O-[CHR^3(CH_2)_m-O]_n-R^2$ wherein R^1 is a (C1 - C8) alkyl group or a (C3 - C8) cycloalkyl group, wherein each of said groups is partially fluorinated or perfluorinated so that at least one hydrogen atom of the group is replaced by fluorine ; R^2 is a (C1 - C8) alkyl carbonyl or (C3 - C8) cycloalkyl carbonyl group, wherein said alkylcarbonyl or cycloalkylcarbonyl group may optionally be partially fluorinated or perfluorinated ; R^3 is a hydrogen atom or a (C1 - C8) alkyl or (C3 - C8) cycloalkyl group ; m is 0, 1, 2 or 3, and n is 1, 2 or 3.

A preferred process for the manufacture of the fluorinated derivatives of 1,3-dioxolan-2-one are disclosed in WO 2011/048053. The other compounds can be synthesized in a known manner and are also commercially available, for example from ABCR GmbH & Co.KG, Karlsruhe, Germany.

5 In the context of the present invention, the term “comprising” is intended to mean also “consisting of”. The plural is intended to include the singular, and vice versa.

Suitable solvents (which generally are aprotic organic solvents) can be selected, for example, from organic carbonates, but also lactones, formamides, 10 pyrrolidinones, oxazolidinones, nitroalkanes, N,N-substituted urethanes, sulfolane, dialkyl sulfoxides, dialkyl sulfites, acetates, nitriles, acetamides, glycol ethers, dioxolanes, dialkyloxyethanes, trifluoroacetamides, are very suitable as solvents.

Preferably, the aprotic organic solvent is selected from the group of dialkyl 15 carbonates (which are linear) and alkylene carbonates (which are cyclic), and wherein the term “alkyl” denotes preferably C1 to C4 alkyl, the term “alkylene” denotes preferably C2 to C7 alkylene groups, including a vinylidene group, wherein the alkylene group preferably comprises a bridge of 2 carbon atoms between the oxygen atoms of the $-O-C(O)-O-$ group ; ketones, nitriles and 20 formamides. Dimethyl formamide, carboxylic acid amides, for example, N,N-dimethyl acetamide and N,N-diethyl acetamide, acetone, acetonitrile, linear dialkyl carbonates, e.g. dimethyl carbonate, diethyl carbonate, methyl ethyl carbonate, cyclic alkylene carbonates, e.g. ethylene carbonate, propylene carbonate, and vinylidene carbonate, are suitable solvents.

25 The electrolyte composition, further to the at least one fluorinated organic compound of the invention and a suitable solvent, comprises at least one electrolyte salt. Such salts have the general formula M_aA_b . M is a metal cation, and A is an anion. The overall charge of the salt M_aA_b is 0. M is preferably selected from Li^+ and NR_4^+ . Preferred anions are PF_6^- , $PO_2F_2^-$, AsF_6^- , BF_4^- , 30 ClO_4^- , $N(CF_3SO_2)_2^-$ and $N(i-C_3F_7SO_2)_2^-$.

Preferably, M is Li^+ . Especially preferably, M is Li^+ and the solution comprises at least one electrolyte salt selected from the group consisting of $LiBF_4$, $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiPO_2F_2$, $LiN(CF_3SO_2)_2$ and $LiN(i-C_3F_7SO_2)_2$. Li bis(oxalato)borate can be applied as an additional additive. The concentration of 35 the electrolyte salt is preferably 1 ± 0.1 molar. Often, the electrolyte composition may comprise $LiPF_6$ and $LiPO_2F_2$.

Another aspect of the present invention concerns compositions comprising at least one solvent, at least one fluorinated organic compound according to the invention and optionally at least one electrolyte salt, wherein the fluorinated organic compound is present in the composition in a concentration from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total weight of the composition. Preferably, the fluorinated organic compound is 4,4,5-trifluoro-1,3-dioxolan-3-one. Also preferably, the composition comprises 4,4,5-trifluoro-1,3-dioxolan-3-one and the at least one solvent is selected from the list consisting of ethylene carbonate, dimethyl carbonate, propylene carbonate, diethyl carbonate, 1,2-dimethoxyethane, γ -butyrolactone or a mixture thereof. More preferably, the solvent is a 1:2 (v/v) mixture of ethylene carbonate and dimethyl carbonate.

Preferably, the composition further comprises at least one electrolyte salt. More preferably, the at least one electrolyte salt is LiPF_6 , LiPO_2F_2 or a mixture thereof, more preferably, the electrolyte salt is LiPF_6 .

Most preferably, the composition comprises 4,4,5-trifluoro-1,3-dioxolan-3-one, a 1:2 (v/v) mixture of ethylene carbonate and dimethyl carbonate and LiPF_6 .

Thus, the invention concerns a process to provide a composition useful for Li ion batteries, Li air batteries or Li sulfur batteries comprising a step of mixing a fluorinated organic compound according to the invention with a solvent and optionally further solvent additives and further optionally with an electrolyte salt.

Yet another aspect of the present invention concerns Li ion batteries, Li air batteries and Li sulfur batteries comprising a composition as outlined above.

Should the disclosure of any patents, patent applications, and publications which are incorporated herein by reference conflict with the description of the present application to the extent that it may render a term unclear, the present description shall take precedence.

The following examples are intended to describe the invention in further detail without the intention to limit it.

Examples :

Test system : Coin half cell consisting of : lithium metal as reference electrode and artificial graphite [SCMG-AR® (artificial graphite obtainable from Showa Denko) : Super-P® (conductive carbon black obtainable from MMM Carbon, Belgium) : PVdF (Solef® 5130 from Solvay Specialty Polymers) binder = 90 : 4 : 6 (wt. %)] as negative material. Polyethylene was used as separator. A standard electrolyte composition [(1.0M LiPF_6 / ethylene carbonate

+ dimethyl carbonate (1:2 (v/v)) was used to which the fluorinated additives according to the invention were added under nitrogen atmosphere.

The coin cells consisted of the following elements : stainless-steel CAN (welded with Ni-mesh), lithium metal ($\phi 17$), separator ($\phi 19$, two), gasket, electrolyte composition (100 μ l), electrode ($\phi 16$, welded with one $0.8t = 0.8$ mm spacer), spring, stainless-steel CAP. The preparation of the electrodes for the coin cells consisted of the following steps in that order : (1) mixing, (2) coating, (3) pressing, (4) slitting, (5) punching, and (6) drying (130 °C in vacuo).

For stabilization, the coin cells were stored at room temperature for a constant time (1 day for the positive coin half cell and 3 day for the negative coin half cell). Thereafter, the cells were charged and discharged for 3 times ("Initial Discharge Capacity"). For the Cycle Performance, 50 cycles were performed under C-rate of 0.3.

Cycle	Type	Mode	Current (mA)	Cut off condition	Remark
1	Rest			$t > 00:05:00$	1 time
2	Discharge	CC/CV	0.1C Current	$t > 12:00:00$	3 times
	Charge	CC	0.1C Current	$V > 1.500$	
	Rest			$t > 00:30:00$	
3	Discharge	CC/CV	0.3C Current	$t > 04:00:00$	50 times
	Charge	CC	0.3C Current	$V > 1.500$	
	Rest			$t > 00:30:00$	
4	Discharge	CC/CV	0.1C Current	$t > 12:00:00$	1 time
	Charge	CC	0.1C Current	$V > 1.500$	

Table 1 : Test conditions

The results show that surprisingly, use of low concentrations of fluorinated organic compounds as additives according to the invention improved the Initial Discharge Capacity as well as the Cycle Performance dramatically. Figure 1 shows that use of an electrolyte composition comprising 0.1 wt % of the solvent additive 4,4,5-trifluoro-1,3-dioxolan-3-one (F3EC) resulted in a discharge capacity of >350 mAh/g after 50 cycles whereas both the use of the standard electrolyte composition without F3EC and the electrolyte composition comprising 1 % resulted in lower discharge capacities of <200 and ≈ 250 mAh/g, respectively. Figure 2 shows that the Initial Discharge Capacity was improved using both 0.1 and 0.3 wt % F3EC as compared to the standard electrolyte composition and as compared to the electrolyte composition using 3 wt % F3EC.

CLAIMS

1. Use of a fluorinated organic compound as a solvent additive for an electrolyte composition, in particular for Li ion batteries, Li air batteries or Li sulfur batteries wherein the concentration of the fluorinated organic compound is
5 equal to or below 1 wt %, preferably equal to or below 0.75 wt %, more preferably equal to or below 0.5 wt % and most preferably equal to or below 0.3 wt % relative to the total weight of the electrolyte composition, wherein the fluorinated organic compound is 4,4,5-trifluoro-1,3-dioxolan-3-one.
2. Use of a fluorinated organic compound according to claim 1 wherein
10 the concentration of the fluorinated organic compound is from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total weight of the electrolyte composition
3. Use of a fluorinated organic compound according to claim 1 or 2 wherein the sum of the individual concentrations of all solvent additives present
15 in the electrolyte is from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total weight of the electrolyte composition.
4. Use of a fluorinated organic compound according to any one of claims 1 to 7 wherein the fluorinated organic compound is the only solvent
20 additive present in the electrolyte composition.
5. A composition comprising at least one solvent, at least one fluorinated organic compound wherein the fluorinated organic compound is 4,4,5-trifluoro-1,3-dioxolan-3-one and optionally at least one electrolyte salt, wherein the
25 fluorinated organic compound is present in the composition in a concentration from 0.005 to 0.95 wt %, preferably from 0.01 to 0.45 wt % and most preferably from 0.05 to 0.3 wt % relative to the total weight of the composition.
6. Use of the composition according to claim 5 as an electrolyte.
7. Use according to claim 6, to improve the initial discharge capacity and/or the cycle performance of a battery.

- 11 -

8. A Li ion battery, Li air battery or Li sulfur battery comprising the composition of claim 5.

Fig. 1

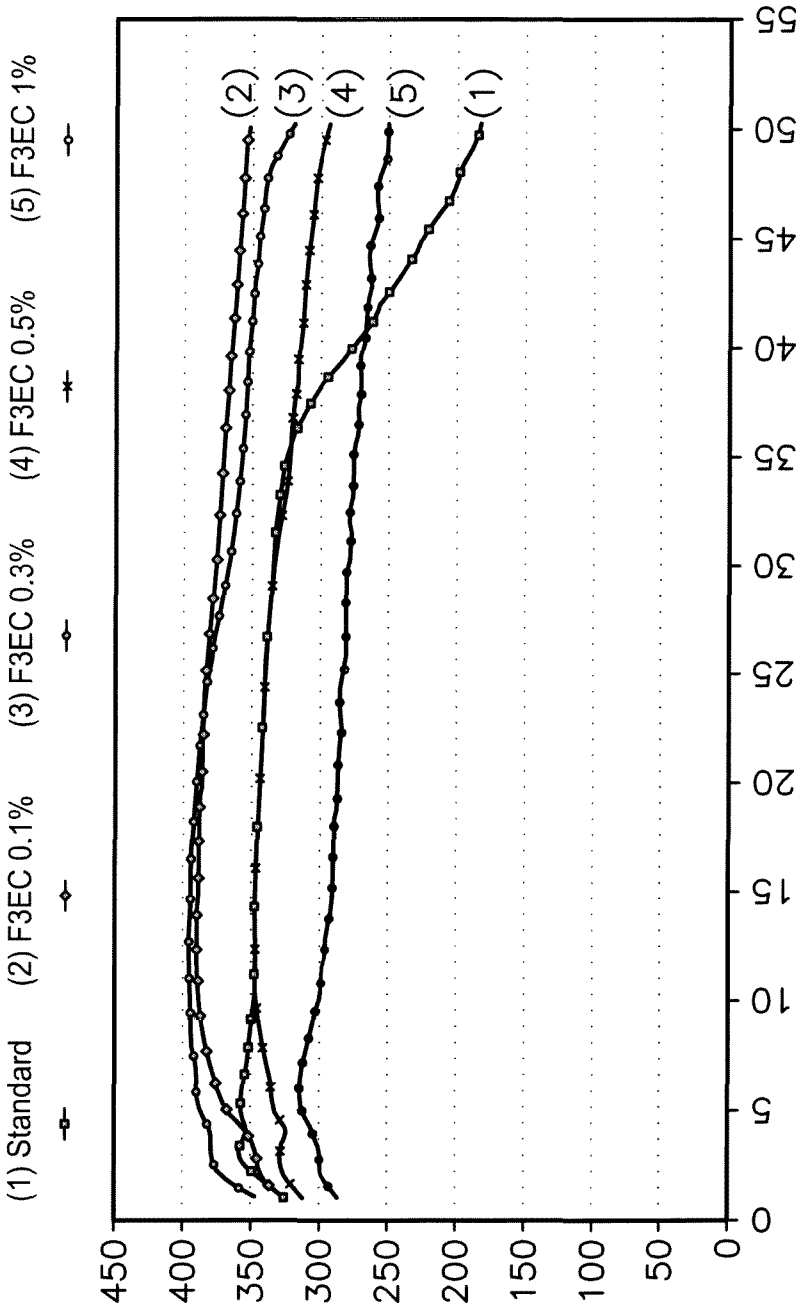
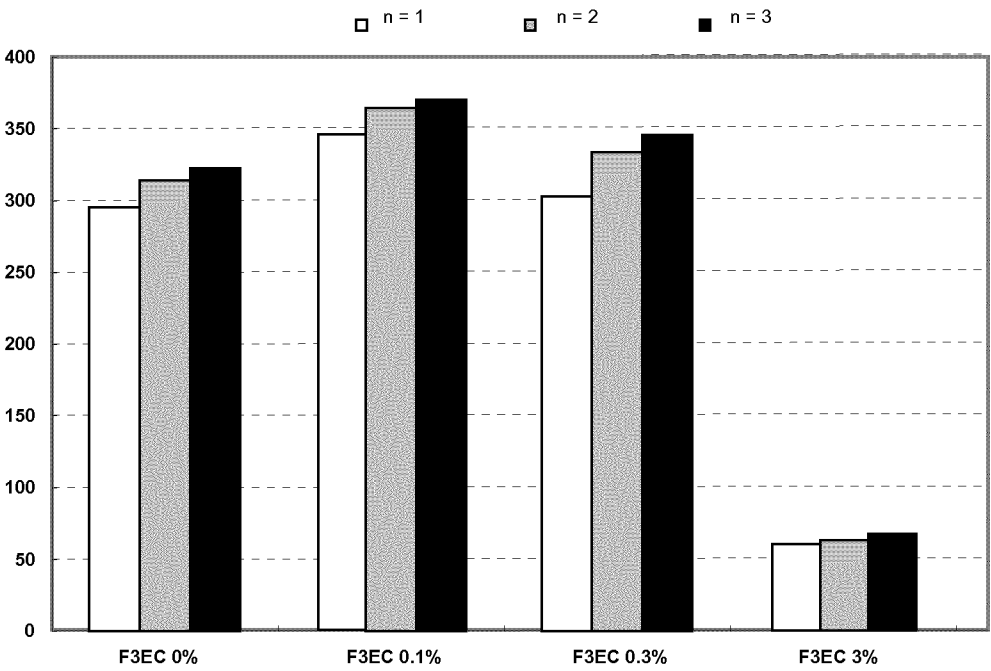


Fig. : 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/066940

A. CLASSIFICATION OF SUBJECT MATTER INV. H01M10/0567 H01M10/052 H01M10/05 H01M6/16 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H01M		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/090154 A1 (IHARA MASAYUKI [JP] ET AL) 17 April 2008 (2008-04-17) the whole document * see [0025] - [0040]; in particular formula 11.2 and 11.4; claims * -----	1-8
X	WO 2011/051275 A1 (SOLVAY FLUOR GMBH [DE]; OLSCHIMKE JENS [DE]; BOMKAMP MARTIN [DE]; EICH) 5 May 2011 (2011-05-05) the whole document * see p.7, 1.25 - p.9, 1.10 ;p.14, 1.9 - 22; claims * -----	1-8
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Date of the actual completion of the international search 24 September 2013		Date of mailing of the international search report 04/10/2013
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Stellmach, Joachim

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