

[0074] (3)锂离子电池的高温存储性能测试

[0075] 在25℃下,将锂离子电池以0.5C恒流充电至4.45V,再以4.45V恒压充电至电流为0.025C,使锂离子电池处于4.45V满充状态,此时检测得到的厚度记为锂离子电池存储前的厚度。然后分别在85℃下存储4小时、在60℃下存储30天,此时检测得到的厚度记为锂离子电池存储后的厚度。

[0076] 锂离子电池高温存储后的厚度膨胀率=(存储后的厚度-存储前的厚度)/存储前的厚度×100%。每次测试15支锂离子电池,取其平均值。相关数据参见表2。

[0077] 表2实施例1-10和对比例1-8的循环性能、倍率性能以及高温存储性能的测试结果

[0078]

	循环 n 次后的容量保持率(%)			不同倍率下的放电容量保持率(%)				85℃存储 4 小时后的厚度膨胀率(%)	60℃存储 30 天后的厚度膨胀率(%)
	50 次	100 次	300 次	0.2C	1C	1.5C	2C		
实施例 1	78.8	73.5	69.7	100	94.4	89.1	77.9	9.25	6.35
实施例 2	94.8	91.4	90.4	100	95.8	91.1	82.5	9.65	12.05
实施例 3	92.6	92.1	87.4	100	96.3	92.2	83.2	8.10	6.75
实施例 4	90.4	85.8	84.1	100	93.2	89.1	83.4	6.95	7.95
实施例 5	82.5	78.8	71.0	100	96.2	92.4	83.4	7.75	9.15
实施例 6	95.9	95.0	92.8	100	96.8	92.8	85.6	5.60	7.35
实施例 7	86.3	85.5	83.1	100	94.4	90.3	86.5	5.35	6.90
实施例 8	98.0	96.6	93.4	100	96.6	94.5	92.0	4.25	6.20
实施例 9	96.8	95.2	93.2	100	97.9	93.6	89.5	4.45	6.40

[0079]

实施例 10	98.2	97.0	94.5	100	96.5	92.5	84.7	3.80	6.10
对比例 1	51.0	41.6	34.9	100	91.5	81.2	68.5	34.50	38.60
对比例 2	55.0	47.8	40.5	100	91.9	68.8	71.0	30.80	36.50
对比例 3	57.4	52.7	46.6	100	92.7	86.4	79.7	25.30	31.20
对比例 4	62.1	56.1	47.9	100	91.1	78.0	59.2	24.10	30.60
对比例 5	64.9	75.6	47.3	100	91.3	80.2	63.4	18.50	26.70
对比例 6	69.9	64.6	50.5	100	89.6	78.5	51.0	17.20	25.50
对比例 7	78.8	73.5	59.7	100	90.1	80.4	56.3	16.80	23.10
对比例 8	84.8	81.4	80.4	100	92.3	87.8	78.1	17.30	22.90

[0080] (4)锂离子电池的低温放电性能测试

[0081] 在25℃下,将锂离子电池以1C恒流充电至4.45V,再以4.45V恒压充电至截止电流为0.1C,之后以0.5C恒流放电至3.0V,测量锂离子电池的放电容量,记为初始放电容量。

[0082] 在25℃下,将锂离子电池以1C恒流充电至4.45V,再以4.45V恒压充电至截止电流为0.1C,然后将各充电态的锂离子电池分别放入-10℃和-20℃的低温箱中,放置120分钟,

再以1C恒流放电至3.0V,记录锂离子电池低温存储后的放电容量以及终止内阻。

[0083] 锂离子电池低温放电后的容量比率=锂离子低温存储后的放电容量/锂离子电池在25℃下的初始放电容量×100%。每次测试5支锂离子电池,取其平均值。相关数据参见表3。

[0084] 表3实施例1-10和对比例1-8的低温放电性能测试结果

[0085]

	-10℃		-20℃	
	容量比率 (%)	终止内阻 (mΩ)	容量比率 (%)	终止内阻 (mΩ)
实施例 1	67.4	18.8	42.1	26.9
实施例 2	67.4	17.0	42.5	22.9
实施例 3	67.8	16.6	43.1	22.2
实施例 4	67.3	18.2	42.6	23.8
实施例 5	66.8	17.4	42.1	22.8
实施例 6	67.2	17.3	43.4	22.6
实施例 7	68.0	16.2	43.6	22.4
实施例 8	86.4	14.1	53.9	20.7
实施例 9	87.3	12.8	55.0	19.6
实施例 10	88.5	12.0	59.2	17.8
对比例 1	39.3	41.2	19.6	46.3

[0086]

对比例 2	43.6	39.0	20.0	45.3
对比例 3	53.8	32.5	27.7	36.6
对比例 4	46.0	32.0	28.0	34.5
对比例 5	39.9	40.4	20.6	45.4
对比例 6	45.0	32.0	28.0	34.5
对比例 7	49.3	28.2	39.6	32.3
对比例 8	52.5	22.9	40.0	31.6

[0087] (5)锂离子电池的热箱测试

[0088] 在25℃下,将锂离子电池以1.0C恒流充电至4.45V,然后以4.45V恒压充电至电流降至0.05C,充电停止;把锂离子电池放在热箱中,以5℃/min的升温速度从25℃开始升温至150℃,到达150℃后维持温度不变,然后开始计时,1h后观察锂离子电池的状态。锂离子电池通过该测试的标准为:无冒烟、无起火、无爆炸,其中每组测试5支锂离子电池。相关数据参见表4。

[0089] 表4实施例1-10与对比例1-8的热箱测试结果

[0090]

电池编号	锂离子电池热箱测试后的状态
实施例1	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例2	4支锂离子电池均通过,另外一支锂离子电池有起火现象
实施例3	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例4	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例5	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例6	5支锂离子电池均通过,没有冒烟、起火、爆炸现象

实施例7	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例8	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例9	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
实施例10	5支锂离子电池均通过,没有冒烟、起火、爆炸现象
对比例1	5支锂离子电池均有起火现象
对比例2	5支锂离子电池均有起火现象
对比例3	1支锂离子电池通过,另外4支锂离子电池均有起火现象
对比例4	1支锂离子电池通过,另外4支锂离子电池均有起火现象
对比例5	2支锂离子电池通过,另外3支锂离子电池均有起火现象
对比例6	2支锂离子电池通过,另外3支锂离子电池均有起火现象
对比例7	2支锂离子电池通过,另外3支锂离子电池均有起火现象
对比例8	2支锂离子电池通过,另外3支锂离子电池均有起火现象

[0091] 从上述表2至表4中的相关数据可以得知,对比例5-6仅含有烷基硫酸锂或氟代醚,单独使用烷基硫酸锂容易分解产生硫酸锂和烷基,使得电极表面的保护膜阻抗增加,而单独使用氟代醚所形成的SEI膜不稳定,循环过程中容易分解,导致锂离子电池的循环性能和倍率性能下降。在实施例7中,同时加入烷基硫酸锂和氟代醚,二者组合使用可以减小正极表面保护膜的厚度以及阻抗,改善正极表面形成保护膜的均一性和稳定性,同时可以在负极表面形成稳定的SEI膜,烷基硫酸锂中的锂离子对氟代醚的成膜具有诱导作用,使氟代醚分散均匀,形成稳定致密的复合保护膜。而且复合保护膜中由于烷基硫酸锂中的锂离子和氟代醚中的氧原子、氟原子存在络合作用,使得复合保护膜在高温下或高压下比较稳定,不会随着循环进行发生分解,从而提高锂离子电池性能。当在电解液中进一步加入第二添加剂(实施例9-10)时,锂离子电池的性能得到进一步改善。这是由于第二添加剂对SEI膜的形成具有促进和稳定作用,尤其是在高温或高压条件下,抑制循环过程中SEI膜被破坏。

[0092] 对比实施例8和对比例4可知,对比例4中仅使用第二添加剂,未加入烷基硫酸锂和氟代醚,导致锂离子电池的性能均较差。这是由于单独的第二添加剂所形成的保护膜阻抗偏大。

Abstract of CN108242567 (A)

The invention provides an electrolyte and a secondary battery. The electrolyte comprises electrolyte salt, an organic solvent and an additive. The additive comprises silicyl sulfate and dinitrile compound and/or trinitrile compound. After the electrolyte is applied to a secondary battery, under the synergistic effect of the substances, the high-temperature storage performance and high-temperaturecyclic performance of the secondary battery can be improved at the same time.

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(54)发明名称

电解液及二次电池

(57)摘要

本发明提供一种电解液及二次电池。所述电解液包括电解质盐、有机溶剂以及添加剂。所述添加剂包括硅烷基硫酸酯以及二腈化合物和/或三腈化合物。当所述电解液应用到二次电池中后,在上述物质的协同作用下,能够同时提高二次电池的高温存储性能和高温循环性能。

CN 108242567 A

1. 一种电解液, 包括:

电解质盐;

有机溶剂; 以及

添加剂;

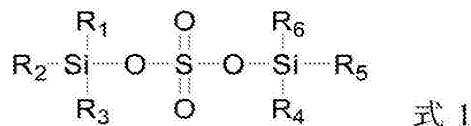
其特征在于,

所述添加剂包括:

硅烷基硫酸酯; 以及

二腈化合物和/或三腈化合物。

2. 根据权利要求1所述的电解液, 其特征在于, 所述硅烷基硫酸酯选自式1所示的化合物中的一种或几种:



其中,

R₁、R₂、R₃、R₄、R₅、R₆各自独立地选自碳原子数为1~5的烷基、碳原子数为2~5的烯基、碳原子数为2~5的炔基、碳原子数为1~5的烷氧基中的一种, 烷基、烯基、炔基、烷氧基中的H原子还可被F、Cl、Br、I、氰基、羧基、磺酸基中的一种或几种取代。

3. 根据权利要求2所述的电解液, 其特征在于, 所述硅烷基硫酸酯选自双(三甲基硅基)硫酸酯、双(三乙基硅基)硫酸酯、双(三正丙基硅基)硫酸酯、双(三异丙基硅基)硫酸酯、双(三正丁基硅基)硫酸酯、双(三异丁基硅基)硫酸酯、双(三叔丁基硅基)硫酸酯、双(三甲氧基硅基)硫酸酯、双(三乙氧基硅基)硫酸酯、双(三正丙氧基硅基)硫酸酯、双(三异丙氧基硅基)硫酸酯、双(三正丁氧基硅基)硫酸酯、双(三仲丁氧基硅基)硫酸酯、双(三叔丁氧基硅基)硫酸酯、双(三氟甲基硅基)硫酸酯、三甲基硅基三乙基硅基硫酸酯、双(三乙基硅基)硫酸酯、双(三乙炔基硅基)硫酸酯中的一种或几种。

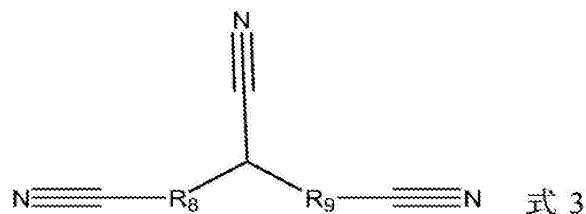
4. 根据权利要求1所述的电解液, 其特征在于,

所述二腈化合物选自式2所示的化合物中的一种或几种:

NC-R₇-CN 式2

在式2中, R₇选自碳原子数为1~20的亚烷基、碳原子数为1~20的卤代亚烷基、碳原子数为1~20的亚烷氧基、碳原子数为1~20的卤代亚烷氧基、碳原子数为2~20的亚烯基、碳原子数为2~20的卤代亚烯基中的一种, 卤原子选自F、Cl、Br、I中的一种或几种;

所述三腈化合物选自式3所示的化合物中的一种或几种:



在式3中, R₈、R₉各自独立地选自碳原子数为1~20的亚烷基、碳原子数为1~20的亚烷氧基、碳原子数为1~20的卤代亚烷基、碳原子数为1~20的卤代亚烷氧基、碳原子数为2~20

的亚烯基、碳原子数为2~20的卤代亚烯基中的一种,卤原子选自F、Cl、Br、I中的一种或几种。

5. 根据权利要求4所述的电解液,其特征在于,

在式2中, R_7 选自碳原子数为1~10的亚烷基、碳原子数为1~10的卤代亚烷基、碳原子数为1~10的亚烷氧基、碳原子数为1~10的卤代亚烷氧基、碳原子数为2~10的亚烯基、碳原子数为2~10的卤代亚烯基中的一种,其中,卤原子选自F、Cl、Br中的一种或几种;

在式3中, R_8 、 R_9 各自独立地选自碳原子数为1~10的亚烷基、碳原子数为1~10的亚烷氧基、碳原子数为1~10的卤代亚烷基、碳原子数为1~10的卤代亚烷氧基、碳原子数为2~10的亚烯基、碳原子数为2~10的卤代亚烯基中的一种,其中,卤原子选自F、Cl、Br中的一种或几种。

6. 根据权利要求5所述的电解液,其特征在于,

所述二腈化合物选自丙二腈、丁二腈、2-甲基丁二腈、四甲基丁二腈、戊二腈、2-甲基戊二腈、己二腈、富马二腈、2-亚甲基戊二腈、3,5-二氧杂-庚二腈、乙二醇二(2-氰基乙基)醚、二乙二醇二(2-氰基乙基)醚、三乙二醇二(2-氰基乙基)醚、四乙二醇二(2-氰基乙基)醚、1,2-二(2-氰乙氧基)乙烷、1,3-二(2-氰基乙氧基)丙烷、1,4-二(2-氰基乙氧基)丁烷、1,5-二(2-氰基乙氧基)戊烷、乙二醇二(4-氰基丁基)醚、1,6-二氰基己烷、1,2-二溴-2,4-二氰基丁烷中的一种或几种;

所述三腈化合物选自1,3,6-己烷三腈、1,2,3-丙三甲腈、1,3,5-戊三甲腈中的一种或几种。

7. 根据权利要求4所述的电解液,其特征在于,在式3中, R_8 、 R_9 形成环状结构。

8. 根据权利要求7所述的电解液,其特征在于,所述三腈化合物选自1,3,5-苯三腈、1,3,5-环己烷三甲腈中的一种或两种。

9. 根据权利要求1所述的电解液,其特征在于,

所述硅烷基硫酸酯的含量为所述电解液的总重量的0.5%~10%,优选地,所述硅烷基硫酸酯的含量为所述电解液的总重量的1%~5%;

所述二腈化合物和/或三腈化合物的总含量为所述电解液的总重量的0.5%~10%,优选地,所述二腈化合物和/或三腈化合物的总含量为所述电解液的总重量的1%~5%。

10. 一种二次电池,其特征在于,包括根据权利要求1-9中任一项所述的电解液。

电解液及二次电池

技术领域

[0001] 本发明涉及电池技术领域,尤其涉及一种电解液及二次电池。

背景技术

[0002] 随着智能手机、笔记本电脑以及平板电脑等电子产品的应用越来越广泛,锂离子二次电池作为电子产品的工作电源,具有能量密度高、无记忆效应、工作电压高等特点,正逐步取代传统的Ni-Cd、MH-Ni电池。然而随着电子产品市场需求的扩大及动力、储能设备的发展,人们对锂离子二次电池的要求不断提高,开发具有高能量密度和满足快速充放电的锂离子二次电池成为当务之急。目前,有效的方法是提高电极活性材料的电压、压实密度以及选择合适的电解液。

[0003] 目前,锂离子二次电池广泛应用的电解液包括以六氟磷酸锂为导电锂盐和以环状碳酸酯和链状碳酸酯的混合物溶剂,然而上述电解液仍存在诸多的不足,特别是在高电压下,锂离子二次电池的性能较差,例如循环性能差、高温存储性能差、安全性能差以及倍率性能差。

发明内容

[0004] 鉴于背景技术中存在的问题,本发明的目的在于提供一种电解液及二次电池,当所述电解液应用到二次电池中后,能够同时提高二次电池的高温存储性能和高温循环性能。

[0005] 为了达到上述目的,在本发明的一方面,本发明提供了一种电解液,其包括电解质盐、有机溶剂以及添加剂。所述添加剂包括硅烷基硫酸酯以及二腈化合物和/或三腈化合物。

[0006] 在本发明的另一方面,本发明提供了一种二次电池,其包括根据本发明一方面所述的电解液。

[0007] 相对于现有技术,本发明的有益效果包括,但不限于:

[0008] 本发明的电解液同时包括硅烷基硫酸酯以及二腈化合物和/或三腈化合物,当其应用到二次电池中后,在上述物质的协同作用下,能够同时提高二次电池的高温存储性能和高温循环性能。

具体实施方式

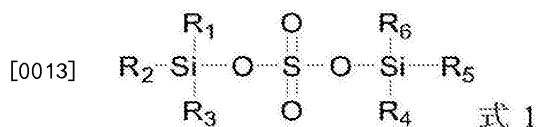
[0009] 下面详细说明根据本发明的电解液及二次电池。

[0010] 首先说明根据本发明第一方面的电解液。

[0011] 根据本发明第一方面的电解液包括电解质盐、有机溶剂以及添加剂。所述添加剂包括硅烷基硫酸酯以及二腈化合物和/或三腈化合物。

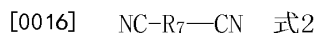
[0012] 在根据本发明第一方面所述的电解液中,所述硅烷基硫酸酯具有较高的还原电位,可以改善二次电池的高温循环性能。二腈化合物和三腈化合物易与正极络合,减小高温

时界面副反应,抑制二次电池高温产气,但是由于腈基具有较强的吸电子特性,容易在负极得到电子发生还原反应,且其还原产物不稳定会沉积到负极上,影响二次电池的循环性能。当电解液中同时包含上述物质时,由于硅烷基硫酸酯优先在负极表面成膜,因此可以抑制二腈化合物和/或三腈化合物在负极的副反应,因此在上述物质的协同作用下,能够同时提高二次电池的高温存储性能和高温循环性能。在根据本发明第一方面所述的电解液中,所述硅烷基硫酸酯可选自式1所示的化合物中的一种或几种。其中, R_1 、 R_2 、 R_3 、 R_4 、 R_5 、 R_6 各自独立地选自碳原子数为1~5的烷基、碳原子数为2~5的烯基、碳原子数为2~5的炔基、碳原子数为1~5的烷氧基中的一种,烷基、烯基、炔基、烷氧基中的H原子还可被F、Cl、Br、I、氰基、羧基、磺酸基中的一种或几种取代。



[0014] 在根据本发明第一方面所述的电解液中,具体地,所述硅烷基硫酸酯可选自双(三甲基硅基)硫酸酯、双(三乙基硅基)硫酸酯、双(三正丙基硅基)硫酸酯、双(三异丙基硅基)硫酸酯、双(三正丁基硅基)硫酸酯、双(三异丁基硅基)硫酸酯、双(三叔丁基硅基)硫酸酯、双(三甲氧基硅基)硫酸酯、双(三乙氧基硅基)硫酸酯、双(三正丙氧基硅基)硫酸酯、双(三异丙氧基硅基)硫酸酯、双(三正丁氧基硅基)硫酸酯、双(三仲丁氧基硅基)硫酸酯、双(三叔丁氧基硅基)硫酸酯、双(三氟甲基硅基)硫酸酯、三甲基硅基三乙基硅基硫酸酯、双(三乙基硅基)硫酸酯、双(三乙炔基硅基)硫酸酯中的一种或几种。

[0015] 在根据本发明第一方面所述的电解液中,所述二腈化合物可选自式2所示的化合物中的一种或几种。在式2中, R_7 选自碳原子数为1~20的亚烷基、碳原子数为1~20的卤代亚烷基、碳原子数为1~20的亚烷氧基、碳原子数为1~20的卤代亚烷氧基、碳原子数为2~20的亚烯基、碳原子数为2~20的卤代亚烯基中的一种。其中,卤原子可选自F、Cl、Br、I中的一种或几种。



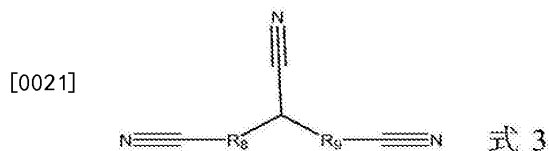
[0017] 在根据本发明第一方面所述的电解液中,优选地, R_7 选自碳原子数为1~10的亚烷基、碳原子数为1~10的卤代亚烷基、碳原子数为1~10的亚烷氧基、碳原子数为1~10的卤代亚烷氧基、碳原子数为2~10的亚烯基、碳原子数为2~10的卤代亚烯基中的一种,其中,优选地,卤原子可选自F、Cl、Br中的一种或几种。

[0018] 在根据本发明第一方面所述的电解液中,在式2中,亚烷氧基、卤代亚烷氧基中的氧原子数可以为1个、2个或多个。

[0019] 在根据本发明第一方面所述的电解液中,具体地,所述二腈化合物可选自丙二腈、丁二腈、2-甲基丁二腈、四甲基丁二腈、戊二腈、2-甲基戊二腈、己二腈、富马二腈、2-亚甲基戊二腈、3,5-二氧杂-庚二腈、乙二醇二(2-氰基乙基)醚、二乙二醇二(2-氰基乙基)醚、三乙二醇二(2-氰基乙基)醚、四乙二醇二(2-氰基乙基)醚、1,2-二(2-氰基乙氧基)乙烷、1,3-二(2-氰基乙氧基)丙烷、1,4-二(2-氰基乙氧基)丁烷、1,5-二(2-氰基乙氧基)戊烷、乙二醇二(4-氰基丁基)醚、1,6-二氰基己烷、1,2-二溴-2,4-二氰基丁烷中的一种或几种。

[0020] 在根据本发明第一方面所述的电解液中,所述三腈化合物可选自式3所示的化合物中的一种或几种。在式3中, R_8 、 R_9 各自独立地选自碳原子数为1~20的亚烷基、碳原子数为

1~20的亚烷基、碳原子数为1~20的卤代亚烷基、碳原子数为1~20的卤代亚烷氧基、碳原子数为2~20的亚烯基、碳原子数为2~20的卤代亚烯基中的一种。其中,卤原子可选自F、Cl、Br、I中的一种或几种。



[0022] 在根据本发明第一方面所述的电解液中,优选地, R_8 、 R_9 各自独立地选自碳原子数为1~10的亚烷基、碳原子数为1~10的亚烷氧基、碳原子数为1~10的卤代亚烷基、碳原子数为1~10的卤代亚烷氧基、碳原子数为2~10的亚烯基、碳原子数为2~10的卤代亚烯基中的一种,其中,优选地,卤原子可选自F、Cl、Br中的一种或几种。

[0023] 在根据本发明第一方面所述的电解液中,在式3中,亚烷氧基、卤代亚烷氧基中的氧原子数可以为1个、2个或多个。

[0024] 在根据本发明第一方面所述的电解液中,具体地,所述三腈化合物可选自1,3,6-己烷三腈、1,2,3-丙三甲腈、1,3,5-戊三甲腈中的一种或几种。

[0025] 在根据本发明第一方面所述的电解液中,在式3中, R_8 、 R_9 形成环状结构,即所述三腈化合物具有环状结构。具体地,所述三腈化合物可选自1,3,5-苯三腈、1,3,5-环己烷三甲腈中的一种或两种。

[0026] 根据本发明第一方面所述的电解液中,所述硅烷基硫酸酯的含量可为所述电解液的总重量的0.5%~10%,优选地,所述硅烷基硫酸酯的含量可为所述电解液的总重量的1%~5%。

[0027] 根据本发明第一方面所述的电解液中,所述二腈化合物和/或三腈化合物的总含量可为所述电解液的总重量的0.5%~10%,优选地,所述二腈化合物和/或三腈化合物的总含量可为所述电解液的总重量的1%~5%。

[0028] 在根据本发明第一方面所述的电解液中,所述电解质盐可选自锂盐、钠盐或锌盐,依据所述电解液应用的二次电池的不同而不同。

[0029] 在根据本发明第一方面所述的电解液中,所述电解质盐的含量为所述电解液的总重量的6.2%~25%,优选地,所述电解质盐的含量为所述电解液的总重量的6.25%~18.8%,进一步优选地,所述电解质盐的含量为所述电解液的总重量的10%~15%。

[0030] 在根据本发明第一方面所述的电解液中,所述有机溶剂的具体种类并没有特别的限制,可根据实际需求进行选择。优选地,使用非水有机溶剂。所述非水有机溶剂可包括任意种类的碳酸酯、羧酸酯。碳酸酯可包括环状碳酸酯或者链状碳酸酯。所述非水有机溶剂还可包括碳酸酯的卤代化合物。具体地,所述有机溶剂可选自碳酸亚乙酯(EC)、碳酸亚丙酯(PC)、碳酸亚丁酯、碳酸亚戊酯、氟代碳酸亚乙酯、碳酸二甲酯(DMC)、碳酸二乙酯(DEC)、碳酸二丙酯、碳酸甲乙酯(EMC)、甲酸甲酯、甲酸乙酯、乙酸乙酯、丙酸丙酯、丙酸乙酯、 γ -丁内酯(BL)、四氢呋喃(THF)中的一种或几种。

[0031] 在根据本发明第一方面所述的电解液中,需要说明的是,说明书中出现的“烷基”、“烯基”、“炔基”、“烷氧基”、“亚烷基”、“卤代亚烷基”、“亚烷氧基”、“卤代亚烷氧基”、“亚烯基”、“卤代亚烯基”等既可为链状结构,也可为环状结构。

[0032] 其次说明根据本发明第二方面的二次电池。

[0033] 根据本发明第二方面的二次电池包括根据本发明第一方面所述的电解液。

[0034] 在根据本发明第二方面所述的二次电池中,所述二次电池还包括:正极片、负极片以及隔离膜。所述正极片包括正极集流体和设置于所述正极集流体上的正极膜片,所述正极膜片包括正极活性材料、粘接剂和导电剂。所述负极片包括负极集流体和设置于所述负极集流体上的负极膜片,所述负极膜片包括负极活性材料、粘接剂,也可以包括导电剂。所述隔离膜间隔于正极片和负极片之间。

[0035] 在根据本发明第二方面所述的二次电池中,所述隔离膜可以是现有二次电池中使用的任何隔离膜材料,例如聚乙烯、聚丙烯、聚偏氟乙烯以及它们的多层复合膜,但不仅限于这些。

[0036] 在根据本发明第二方面所述的二次电池中,所述二次电池可为锂离子二次电池、钠离子二次电池或锌离子二次电池。

[0037] 当二次电池为锂离子二次电池时,所述电解质盐可选自锂盐,所述锂盐可选自 LiPF_6 、 LiBF_4 、 LiFSI 、 LiTFSI 、 LiClO_4 、 LiAsF_6 、 LiBOB 、 LiDFOB 、 LiPO_2F_2 、 LiTFOP 、 $\text{LiN}(\text{SO}_2\text{RF})_2$ 、 $\text{LiN}(\text{SO}_2\text{F})(\text{SO}_2\text{RF})$ 中的一种或几种,其中, $\text{RF}=\text{C}_n\text{F}_{2n+1}$,表示饱和全氟烷基, n 为1~10内的整数。优选地,所述锂盐为 LiPF_6 。

[0038] 当二次电池为锂离子二次电池时,所述正极活性材料可选自钴酸锂(LiCoO_2)、镍酸锂(LiNiO_2)、尖晶石型的 LiMn_2O_4 、橄榄石型的 LiMPO_4 、三元正极材料 $\text{LiNi}_x\text{A}_y\text{B}_{(1-x-y)}\text{O}_2$ 以及 $\text{Li}_{1-x'}(\text{A}'_y\text{B}'_{z'}\text{C}_{1-y'-z'})\text{O}_2$ 中的一种或几种。其中,在橄榄石型的 LiMPO_4 中, M 选自 Co 、 Ni 、 Fe 、 Mn 、 V 中的一种或几种;在三元正极材料 $\text{LiNi}_x\text{A}_y\text{B}_{(1-x-y)}\text{O}_2$ 中, A 、 B 各自独立地选自 Co 、 Al 、 Mn 中的一种,且 A 和 B 不相同, $0 < x < 1$, $0 < y < 1$ 且 $x+y < 1$;在三元正极材料 $\text{Li}_{1-x'}(\text{A}'_y\text{B}'_{z'}\text{C}_{1-y'-z'})\text{O}_2$ 中, A' 、 B' 、 C 各自独立地选自 Co 、 Ni 、 Fe 、 Mn 中的一种, $0 < x' < 1$, $0 \leq y' < 1$, $0 \leq z' < 1$ 且 $y'+z' < 1$,且 A' 、 B' 、 C 不相同。

[0039] 当二次电池为锂离子二次电池时,所述负极活性材料可以选自金属锂。所述负极活性材料也可以选自在 $< 2\text{V}(\text{vs. Li/Li}^+)$ 时可以嵌入锂的材料,具体地,所述负极活性材料可选自天然石墨、人造石墨、中间相微碳球(简称为MCMB)、硬碳、软碳、硅、硅-碳复合物、 Li-Sn 合金、 Li-Sn-O 合金、 Sn 、 SnO 、 SnO_2 、尖晶石结构的锂化 TiO_2 - $\text{Li}_4\text{Ti}_5\text{O}_{12}$ 、 Li-Al 合金中的一种或几种。

[0040] 当二次电池为钠离子二次电池或锌离子二次电池时,仅需改变对应的正极活性材料、负极活性材料、电解质盐即可。

[0041] 下面结合实施例,进一步阐述本申请。应理解,这些实施例仅用于说明本申请而并不用于限制本申请的范围。在实施例中仅示出二次电池为锂离子二次电池的情况,但本发明不限于此。

[0042] 在以下实施例中,所用到的材料、试剂以及仪器如没有特殊说明,均可从商业途径购买获得。

[0043] 为了便于说明,在下述实施例中用到的添加剂简写如下:

[0044] A1:双(三氟甲基硅基)硫酸酯

[0045] A2:三甲基硅基三乙基硅基硫酸酯

[0046] B1:1,2-二(2-氰乙氧基)乙烷

[0047] B2:1,3,6-己烷三腈

[0048] 实施例1-11以及对比例1-4中的锂离子二次电池均按照下述方法进行制备。

[0049] (1) 正极片制备

[0050] 将正极活性材料钴酸锂 (LiCoO_2)、粘接剂聚偏氟乙烯、导电剂乙炔黑按照重量比98:1:1进行混合,加入N-甲基吡咯烷酮 (NMP),在真空搅拌机作用下搅拌至体系成均一透明状,获得正极浆料;将正极浆料均匀涂覆于厚度为 $12\mu\text{m}$ 的正极集流体铝箔上;将铝箔在室温晾干后转移至 120°C 烘箱干燥1h,然后经过冷压、分切得到正极片。

[0051] (2) 负极片制备

[0052] 将负极活性材料人造石墨、增稠剂羧甲基纤维素钠 (CMC)、粘接剂丁苯橡胶按照重量比98:1:1进行混合,加入去离子水,在真空搅拌机作用下获得负极浆料;将负极浆料均匀涂覆在厚度为 $8\mu\text{m}$ 的负极集流体铜箔上;将铜箔在室温晾干后转移至 120°C 烘箱干燥1h,然后经过冷压、分切得到负极片。

[0053] (3) 电解液制备

[0054] 在含水量 $<10\text{ppm}$ 的氩气气氛手套箱中,将EC、PC、DEC按照体积比为EC:PC:DEC=1:1:1进行混合,接着将充分干燥的锂盐 LiPF_6 溶解于混合有机溶剂中,之后加入硅烷基硫酸酯、二腈化合物、三腈化合物,混合均匀后获得电解液。其中, LiPF_6 的含量为电解液的总重量的12.5%。电解液中所用到的硅烷基硫酸酯、二腈化合物、三腈化合物的具体种类以及含量如表1所示。在表1中,硅烷基硫酸酯、二腈化合物、三腈化合物的含量为基于电解液的总重量计算得到的重量百分数。

[0055] (4) 隔离膜的制备

[0056] 选用 $16\mu\text{m}$ 厚的聚丙烯隔离膜(型号为C210,由Celgard公司提供)。

[0057] (5) 锂离子二次电池的制备

[0058] 将正极片、隔离膜、负极片按顺序叠好,使隔离膜处于正、负极片之间起到隔离的作用,然后卷绕得到裸电芯;将裸电芯置于外包装箔中,将上述制备好的电解液注入到干燥后的裸电芯中,经过真空封装、静置、化成、整形等工序,获得锂离子二次电池。

[0059] 表1 实施例1-11以及对比例1-4的添加剂及含量

[0060]

	添加剂 1	添加剂 2
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[0061]

	种类	含量	种类	含量
实施例 1	A1	1%	B1	1%
实施例 2	A1	0.5%	B1	1%
实施例 3	A1	5%	B1	1%
实施例 4	A1	7%	B1	1%
实施例 5	A1	10%	B1	1%
实施例 6	A1	1%	B1	0.5%
实施例 7	A1	1%	B1	5%
实施例 8	A1	1%	B1	7%
实施例 9	A1	1%	B1	10%
实施例 10	A2	1%	B2	1%
实施例 11	A1	1%	B1/B2	0.5%/0.5%
对比例 1	-	-	-	-
对比例 2	A1	1%	-	-
对比例 3	-	-	B1	1%
对比例 4	-	-	B1	5%

[0062] 注：“-”表示未加入。

[0063] 接下来说明锂离子二次电池的测试过程。

[0064] (1) 锂离子二次电池的高温循环性能测试

[0065] 在45℃下,将锂离子二次电池以1C恒流充电至电压为4.45V,进一步以4.45V恒压充电至电流为0.05C,然后以1C恒流放电至电压为3.0V,此时为一个充放电循环过程,此次的放电容量为首次循环的放电容量。将锂离子二次电池按照上述方法进行300次循环充电/放电测试,检测得到第300次循环的放电容量。

[0066] 锂离子二次电池45℃循环300次后的容量保持率(%)=(锂离子二次电池循环300次的放电容量/锂离子二次电池首次循环的放电容量)×100%。上述测试过程每组测试15支锂离子二次电池,取平均值。

[0067] (2) 锂离子二次电池的高温存储性能测试

[0068] 在25℃下,将锂离子二次电池以0.5C恒流充电至电压为4.45V,然后以4.45V恒压充电至电流为0.05C,此时测试锂离子二次电池的厚度并记为 h_0 ;之后将锂离子二次电池放入60℃的恒温箱,存储30天后取出,测试此时锂离子二次电池的厚度并记为 h_1 。

[0069] 锂离子二次电池60℃存储30天后的厚度膨胀率= $[(h_1-h_0)/h_0] \times 100\%$ 。上述测试过程每组测试15支锂离子二次电池,取平均值。

[0070] 表2 实施例1-11以及对比例1-4的测试结果

[0071]

	45℃循环300次后的容量保持率	60℃存储30天后的厚度膨胀率
实施例1	61.2%	15.3%
实施例2	56.1%	15.9%
实施例3	72.5%	14.8%
实施例4	86.1%	15.1%
实施例5	85.9%	15.8%
实施例6	60.5%	20.1%
实施例7	58.3%	7.5%
实施例8	55.9%	5.8%
实施例9	48.8%	3.2%
实施例10	58.0%	7.4%
实施例11	58.3%	9.8%
对比例1	30.4%	45.5%
对比例2	60.3%	45.1%
对比例3	31.8%	15.6%
对比例4	27.1%	8.0%

[0072] 从表2的相关数据分析可以得知,对比例1中没有加入硅烷基硫酸酯以及二腈化合物和/或三腈化合物,锂离子二次电池的高温循环性能以及高温存储性能均较差;当电解液中仅加入硅烷基硫酸酯(对比例2)时,锂离子二次电池的高温循环性能到了显著改善,但高温存储性能无明显变化;当电解液中加入二腈化合物(对比例3)时,锂离子二次电池的高温存储性能得到了改善,但高温循环性能仍较差,且当二腈化合物的含量增加时(对比例4),高温循环性出现明显恶化。

[0073] 当电解液中同时加入硅烷基硫酸酯以及二腈化合物和/或三腈化合物(实施例1-11)时,锂离子二次电池的高温循环性能及高温存储性能均得到改善。

Abstract of CN107275553 (A)

The invention belongs to the technical field of li-ion batteries, and particularly relates to a polymer li-ion battery and a preparation method thereof. The battery comprises a positive plate, a negative plate, an isolating membrane spaced between the positive plate and the negative plate, and electrolyte, wherein a positive lug is arranged in the middle of the positive plate, and negative lugs are arranged at two ends of the negative plate; the compaction density of the positive plate is 3.5 to 4.2g/cm³; the compaction density of the negative plate is 1.55 to 1.70g/cm³. According to the polymer li-ion battery and the preparation method thereof provided by the invention, a battery material formula and a battery cell structure are improved, the positive lug is arranged in the middle of the positive plate, and the negative lugs are arranged at two ends of the negative plate, an electric charge transmission path in the battery is changed through the battery cell structure so as to be shortened, and internal resistance of the battery is reduced, so that the polarization during a battery charging and discharging process is reduced, a fast charging performance of the li-ion battery is effectively improved, the polymer li-ion battery meets the charging and discharging requirement not lower than 5C, and a better cycle performance under high-rate charge/discharge is ensured.



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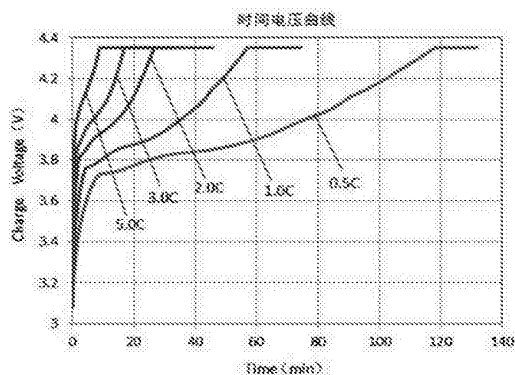
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(54)发明名称

一种聚合物锂离子电池及其制备方法

(57)摘要

本发明属于锂离子电池技术领域,尤其涉及一种聚合物锂离子电池及其制备方法,该电池包括正极片、负极片、间隔于正极片和负极片之间的隔离膜,及其电解液,正极片的中部设有正极耳,负极片的两端设有负极耳;正极片的压实密度为 $3.5\sim 4.2\text{g}/\text{cm}^3$;负极片的压实密度为 $1.55\sim 1.70\text{g}/\text{cm}^3$ 。本发明通过改进电池材料配方和电芯结构,使正极耳设置在正极片中间,使负极耳设置在负极片的两端,这样的电芯结构改变了电池内部中电荷的传递路径,使电荷传递路径变短,电池内阻下降,进而降低电池充放电过程中的极化,有效提升了锂离子电池的快充性能,使聚合物锂离子电池满足5C以上的充放电要求,并保证大倍率充放电下较佳的循环性能。



1. 一种聚合物锂离子电池, 其特征在于: 包括正极片、负极片、间隔于正极片和负极片之间的隔离膜, 及其电解液, 所述正极片的中部设置有正极耳, 所述负极片的两端设置有负极耳;

所述正极片包括正极集流体和涂覆在正极集流体表面上的正极膜片, 所述正极膜片包括重量配比为90%~99%的正极活性材料、0.5%~5%的导电剂、0.5%~5%的聚偏氟乙烯, 所述正极片的压实密度为 $3.5\sim 4.2\text{g}/\text{cm}^3$;

所述负极片包括负极集流体和涂覆在负极集流体表面上的负极膜片, 所述负极膜片包括重量配比为90%~98%的石墨、1%~2%的羧甲基纤维素钠、0.5%~5%的导电剂、0.5%~3%的丁苯橡胶, 所述负极片的压实密度为 $1.55\sim 1.70\text{g}/\text{cm}^3$ 。

2. 根据权利要求1所述的聚合物锂离子电池, 其特征在于: 所述正极活性材料为钴酸锂、磷酸铁锂和三元正极材料中的至少一种, 所述三元正极材料为 $\text{LiNi}_{1-x-y-z}\text{Co}_x\text{Mn}_y\text{Al}_z\text{O}_2$, 其中, $0\leq x\leq 1, 0\leq y\leq 1, 0\leq z\leq 1$ 且 $0\leq x+y+z\leq 1$ 。

3. 根据权利要求1所述的聚合物锂离子电池, 其特征在于: 所述导电剂为导电炭黑、导电石墨、石墨烯、碳纳米管、碳纳米纤维和科琴黑中的至少一种。

4. 根据权利要求1所述的聚合物锂离子电池, 其特征在于: 所述隔离膜为聚乙烯膜、聚丙烯膜、芳纶膜和聚酰亚胺膜中的至少一种, 所述隔离膜的厚度为 $10\sim 20\mu\text{m}$, 孔隙率为40%~50%。

5. 根据权利要求1所述的聚合物锂离子电池, 其特征在于: 所述电解液包括重量配比为5%~15%的锂盐、80%~90%的溶剂和1~10%的添加剂, 所述添加剂为碳酸亚乙烯酯、氟代碳酸乙烯酯、1,3-丙烷磺酸内酯、1,4-丁烷磺酸内酯、二氟草酸硼酸锂、双草酸硼酸锂、硫酸乙烯酯、4-甲基硫酸乙烯酯、丁二酸酐和4-乙基硫酸乙烯酯、丁二腈和己二腈中的至少一种。

6. 根据权利要求5所述的聚合物锂离子电池, 其特征在于: 所述锂盐为六氟磷酸锂、双草酸硼酸锂、二氟草酸硼酸锂、双氟磺酰亚胺锂、四氟硼酸锂和双三氟甲烷磺酰亚胺锂中的至少一种。

7. 根据权利要求5所述的聚合物锂离子电池, 其特征在于: 所述溶剂为碳酸乙烯酯、碳酸丙烯酯、碳酸二甲酯、碳酸二乙酯、碳酸甲乙酯、碳酸甲丙酯、丙酸丙酯、丙酸乙酯、乙酸乙酯、乙酸丙酯、乙酸甲酯、丁酸甲酯、丁酸乙酯和丁酸丙酯中的至少一种。

8. 一种根据权利要求1所述的聚合物锂离子电池的制备方法, 其特征在于, 包括以下步骤:

步骤一、将正极活性材料、聚偏氟乙烯、导电剂按重量配比90%~99%:0.5%~5%:0.5%~5%混合, 加入N-甲基吡咯烷酮溶剂进行搅拌, 制成正极浆料, 然后涂覆在铝箔上进行烘干, 烘干后进行辊压和分切操作, 并在铝箔的中部焊接正极耳, 制成正极片备用;

步骤二、将石墨、羧甲基纤维素钠、丁苯橡胶、导电剂按重量配比90%~98%:1%~2%:0.5%~3%:0.5%~5%混合, 加入水溶剂进行搅拌, 制成负极浆料, 然后涂覆在铜箔上进行烘干, 烘干后进行辊压和分切操作, 并在铜箔的两端焊接负极耳, 制成负极片备用;

步骤三、将氟乙烯类共聚物溶解在丙酮溶剂中, 然后涂覆在隔离膜表面, 制成聚合物多孔膜;

步骤四、在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕, 制成卷芯; 将卷

芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

9.根据权利要求8所述的聚合物锂离子电池的制备方法,其特征在于:所述化成温度为 $60^{\circ}\text{C}\sim 80^{\circ}\text{C}$,充电截止电压为4.4V。

一种聚合物锂离子电池及其制备方法

技术领域

[0001] 本发明属于锂离子电池技术领域,尤其涉及一种聚合物锂离子电池及其制备方法。

背景技术

[0002] 1990年,日本索尼公司率先开发出了商用锂离子电池,该电池的正极材料使用钴酸锂,负极材料使用非石墨化碳,引发了高度的关注。锂离子电池由于比能量大、工作电压高、循环寿命长、环境友好等优点而被广泛应用于消费电子产品、以及需提供动力和储能的产品中。

[0003] 随着电子产品的不断发展,人们对锂离子电池在电子设备上的使用也提出了越来越高的要求,提升电池的能量密度和快速充电的能力,是锂离子电池发展的方向。目前市场上锂离子电池的能量密度一般都在560Wh/L以上,但是电池的充电时间较长,一般在2小时以上,无法满足某些特定使用环境下的快速充电效果,给人们的使用带来不便。目前,许多电池设备要求锂离子电池能够实现快速的充电,同时保证较高的使用寿命;但由于电池材料、电池结构等方面的因素,在进行大电流充放电时,随着使用时间的增加,电池容量会快速降低,导致电池性能发生恶化,影响电池的循环性能和使用寿命。

发明内容

[0004] 本发明的目的在于:针对现有技术的不足,而提供一种可满足在高电压下进行5C快速充放电的要求,具有较高的能量密度,较低的自放电,优异的高低温性能及较长的使用寿命的锂离子电池。

[0005] 为了实现上述目的,本发明采用以下解决方案:

[0006] 一种聚合物锂离子电池,包括正极片、负极片、间隔于正极片和负极片之间的隔离膜,及其电解液,所述正极片的中部设置有正极耳,所述负极片的两端设置有负极耳;

[0007] 所述正极片包括正极集流体和涂覆在正极集流体表面上的正极膜片,所述正极膜片包括重量配比为90%~99%的正极活性材料、0.5%~5%的导电剂、0.5%~5%的聚偏氟乙烯,所述正极片的压实密度为3.5~4.2g/cm³;

[0008] 所述负极片包括负极集流体和涂覆在负极集流体表面上的负极膜片,所述负极膜片包括重量配比为90%~98%的石墨、1%~2%的羧甲基纤维素钠、0.5%~5%的导电剂、0.5%~3%的丁苯橡胶,所述负极片的压实密度为1.55~1.70g/cm³。

[0009] 作为本发明聚合物锂离子电池的一种改进,所述正极活性材料为钴酸锂、磷酸铁锂和三元正极材料中的至少一种,所述三元正极材料为 $\text{LiNi}_{1-x-y-z}\text{Co}_x\text{Mn}_y\text{Al}_z\text{O}_2$,其中, $0 \leq x \leq 1$, $0 \leq y \leq 1$, $0 \leq z \leq 1$ 且 $0 \leq x+y+z \leq 1$ 。

[0010] 作为本发明聚合物锂离子电池的一种改进,所述导电剂为导电炭黑、导电石墨、石墨烯、碳纳米管、碳纳米纤维和科琴黑中的至少一种。

[0011] 作为本发明聚合物锂离子电池的一种改进,所述隔离膜为聚乙烯膜、聚丙烯膜、芳

纶膜和聚酰亚胺膜中的至少一种,所述隔离膜的厚度为10~20 μ m,孔隙率为40%~50%。

[0012] 作为本发明聚合物锂离子电池的一种改进,所述电解液包括重量配比为5%~15%的锂盐、80%~90%的溶剂和1~10%的添加剂,所述添加剂为碳酸亚乙烯酯、氟代碳酸亚乙烯酯、1,3-丙烷磺酸内酯、1,4-丁烷磺酸内酯、二氟草酸硼酸锂、双草酸硼酸锂、硫酸亚乙烯酯、4-甲基硫酸亚乙烯酯、丁二酸酐和4-乙基硫酸亚乙烯酯、丁二腈和己二腈中的至少一种。其中,所述添加剂可以在锂离子电池负极表面形成SEI膜,减少负极界面与电解液的副反应,因此添加剂的加入可使电池保持较佳的高低温循环性能。

[0013] 作为本发明聚合物锂离子电池的一种改进,所述锂盐为六氟磷酸锂、双草酸硼酸锂、二氟草酸硼酸锂、双氟磺酰亚胺锂、四氟硼酸锂和双三氟甲烷磺酰亚胺锂中的至少一种,优选为双氟磺酰亚胺锂和双三氟甲烷磺酰亚胺锂,因为双氟磺酰亚胺锂和双三氟甲烷磺酰亚胺锂能够显著的降低因温度升高而导致的分解效应,可以大幅度延长锂离子电池的使用寿命。

[0014] 作为本发明聚合物锂离子电池的一种改进,所述溶剂为碳酸亚乙烯酯、碳酸丙烯酯、碳酸二甲酯、碳酸二乙酯、碳酸甲乙酯、碳酸甲丙酯、丙酸丙酯、丙酸乙酯、乙酸乙酯、乙酸丙酯、乙酸甲酯、丁酸甲酯、丁酸乙酯和丁酸丙酯中的至少一种。所述溶剂包含碳酸亚乙烯酯、碳酸丙烯酯等高介电常数的溶剂,有利于锂盐的溶解、电池高温及循环性能的提升;此外,包含粘度低且电化学窗口宽的溶剂组分,能够不被高电位的正极所分解,且低粘度能够满足电解液对极片的浸润要求;而且上述非水有机溶剂具有较高的分解电位,在高温、高电压下具有较好的热稳定性和电化学稳定性,从而为4.4V及以上高电压锂离子电池的电性能提供稳定的电化学环境。

[0015] 本发明的另一目的在于:提供一种聚合物锂离子电池的制备方法,其包括以下步骤:

[0016] 步骤一、将正极活性材料、聚偏氟乙烯、导电剂按重量配比90%~99%:0.5%~5%:0.5%~5%混合,加入N-甲基吡咯烷酮溶剂进行搅拌,制成正极浆料,然后涂覆在铝箔上进行烘干,烘干后进行辊压和分切操作,并在铝箔的中部焊接正极耳,制成正极片备用;

[0017] 步骤二、将石墨、羧甲基纤维素钠、丁苯橡胶、导电剂按重量配比90%~98%:1%~2%:0.5%~3%:0.5%~5%混合,加入水溶剂进行搅拌,制成负极浆料,然后涂覆在铜箔上进行烘干,烘干后进行辊压和分切操作,并在铜箔的两端焊接负极耳,制成负极片备用;

[0018] 步骤三、将氟乙烯类共聚物溶解在丙酮溶剂中,然后涂覆在隔离膜表面,制成聚合物多孔膜;

[0019] 步骤四、在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕,制成卷芯;将卷芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

[0020] 其中,本发明所述的隔离膜表面涂有氟乙烯类共聚物,此类共聚物在热引发的条件下能和正负极内的粘结剂发生聚合,使正负极和聚合物多孔膜能够紧密的贴合在一起,减小正负极的膨胀,进一步缩减电池内部体积,使相同体积下电池的能量密度有了很大的提升,同时增加了电池的硬度,保证在电池壳体很薄的情况下整个电池不会变形。

[0021] 作为本发明聚合物锂离子电池的制备方法的一种改进,所述化成温度为60℃~80

℃, 充电截止电压为4.4V。

[0022] 本发明的有益效果在于: 本发明一种聚合物锂离子电池, 包括正极片、负极片、间隔于正极片和负极片之间的隔离膜, 及其电解液, 正极片的中部设置有正极耳, 负极片的两端设置有负极耳; 正极片包括正极集流体和涂覆在正极集流体表面上的正极膜片, 正极膜片包括重量配比为90%~99%的正极活性材料、0.5%~5%的导电剂、0.5%~5%的聚偏氟乙烯, 正极片的压实密度为3.5~4.2g/cm³; 负极片包括负极集流体和涂覆在负极集流体表面上的负极膜片, 负极膜片包括重量配比为90%~98%的石墨、1%~2%的羧甲基纤维素钠、0.5%~5%的导电剂、0.5%~3%的丁苯橡胶, 负极片的压实密度为1.55~1.70g/cm³。本发明通过改进电池材料配方, 并通过改进电芯的结构设计, 使正极耳设置在正极片中间, 使负极耳设置在负极片的两端, 这样的电芯结构改变了电池内部中电荷的传递路径, 使电荷传递路径变短, 电池内阻下降, 进而降低电池充放电过程中的极化, 特别是大倍率充放电过程中的极化, 有效提升了锂离子电池的快充性能, 使聚合物锂离子电池满足5C以上的充放电要求, 并保证大倍率充放电下较佳的循环性能。

附图说明

[0023] 图1为本发明的聚合物锂离子电池中正极片的结构示意图。

[0024] 图2为本发明的聚合物锂离子电池中负极片的结构示意图。

[0025] 图3为本发明的聚合物锂离子电池的倍率充电曲线图。

[0026] 图4为本发明的聚合物锂离子电池的倍率放电曲线图。

[0027] 图5为本发明的聚合物锂离子电池的快充时间电压曲线图。

[0028] 图6为本发明的聚合物锂离子电池的低温放电曲线图。

[0029] 图中: 1-正极片; 11-正极耳; 2-负极片; 21-负极耳。

具体实施方式

[0030] 如图1~2所示, 一种聚合物锂离子电池, 包括正极片1、负极片2、间隔于正极片1和负极片2之间的隔离膜, 及其电解液, 正极片1的中部设置有正极耳11, 负极片的两端设置有负极耳21; 正极片1包括正极集流体和涂覆在正极集流体表面上的正极膜片, 正极膜片包括重量配比为90%~99%的正极活性材料、0.5%~5%的导电剂、0.5%~5%的聚偏氟乙烯, 正极片1的压实密度为3.5~4.2g/cm³; 负极片2包括负极集流体和涂覆在负极集流体表面上的负极膜片, 负极膜片包括重量配比为90%~98%的石墨、1%~2%的羧甲基纤维素钠、0.5%~5%的导电剂、0.5%~3%的丁苯橡胶, 负极片2的压实密度为1.55~1.70g/cm³。

[0031] 优选地, 正极活性材料为钴酸锂、磷酸铁锂和三元正极材料中的至少一种, 三元正极材料为 $\text{LiNi}_{1-x-y-z}\text{Co}_x\text{Mn}_y\text{Al}_z\text{O}_2$, 其中, $0 \leq x \leq 1$, $0 \leq y \leq 1$, $0 \leq z \leq 1$ 且 $0 \leq x+y+z \leq 1$ 。

[0032] 优选地, 导电剂为导电炭黑、导电石墨、石墨烯、碳纳米管、碳纳米纤维和科琴黑中的至少一种。

[0033] 优选地, 隔离膜为聚乙烯膜、聚丙烯膜、芳纶膜和聚酰亚胺膜中的至少一种, 隔离膜的厚度为10~20μm, 孔隙率为40%~50%。

[0034] 优选地, 电解液包括重量配比为5%~15%的锂盐、80%~90%的溶剂和1~10%的添加剂, 添加剂为碳酸亚乙烯酯、氟代碳酸乙烯酯、1,3-丙烷磺酸内酯、1,4-丁烷磺酸内

酯、二氟草酸硼酸锂、双草酸硼酸锂、硫酸乙烯酯、4-甲基硫酸乙烯酯、丁二酸酐和4-乙基硫酸乙烯酯、丁二腈和己二腈中的至少一种。其中,添加剂可以在锂离子电池负极表面形成SEI膜,减少负极界面与电解液的副反应,因此添加剂的加入可使电池保持较佳的高低温循环性能。

[0035] 优选地,锂盐为六氟磷酸锂、双草酸硼酸锂、二氟草酸硼酸锂、双氟磺酰亚胺锂、四氟硼酸锂和双三氟甲烷磺酰亚胺锂中的至少一种,优选为双氟磺酰亚胺锂和双三氟甲烷磺酰亚胺锂,因为双氟磺酰亚胺锂和双三氟甲烷磺酰亚胺锂能够显著的降低因温度升高而导致的分解效应,可以大幅度延长锂离子电池的使用寿命。

[0036] 优选地,溶剂为碳酸乙烯酯、碳酸丙烯酯、碳酸二甲酯、碳酸二乙酯、碳酸甲乙酯、碳酸甲丙酯、丙酸丙酯、丙酸乙酯、乙酸乙酯、乙酸丙酯、乙酸甲酯、丁酸甲酯、丁酸乙酯和丁酸丙酯中的至少一种。溶剂包含碳酸乙烯酯、碳酸丙烯酯等高介电常数的溶剂,有利于锂盐的溶解、电池高温及循环性能的提升;此外,包含粘度低且电化学窗口宽的溶剂组分,能够不被高电位的正极所分解,且低粘度能够满足电解液对极片的浸润要求;而且上述非水有机溶剂具有较高的分解电位,在高温、高电压下具有较好的热稳定性和电化学稳定性,从而为4.4V及以上高电压锂离子电池的电性能提供稳定的电化学环境。

[0037] 下面将结合具体的实施例对本发明及其有益效果作进一步的详细说明,但本发明的实施方式不限于此。

[0038] 实施例1

[0039] 正极片的制备:将钴酸锂、聚偏氟乙烯、导电炭黑和碳纳米管按重量配比96.5:1.2:0.8:1.5混合,加入N-甲基吡咯烷酮溶剂进行搅拌,制成正极浆料,所得正极浆料的固含量为60%,然后涂覆在铝箔上进行烘干,烘干后进行辊压和分切操作,并在铝箔的中部焊接正极耳,制成压实密度为 $3.8\text{g}/\text{cm}^3$ 的正极片。

[0040] 负极片的制备:将石墨、羧甲基纤维素钠、丁苯橡胶、导电炭黑按重量配比95.4:1.5:1.6:1.5混合,加入水溶剂进行搅拌,制成负极浆料,所得负极浆料的固含量为55%,然后涂覆在铜箔上进行烘干,烘干后进行辊压和分切操作,并在铜箔的两端焊接负极耳,制成压实密度为 $1.6\text{g}/\text{cm}^3$ 的负极片。

[0041] 隔离膜的制备:将氟乙烯类共聚物溶解在丙酮溶剂中,然后涂覆在聚乙烯膜表面,制成厚度为 $16\mu\text{m}$,孔隙率为45%的聚合物多孔膜。

[0042] 电解液的制备:将10wt%的六氟磷酸锂溶解于20wt%的碳酸丙烯酯(PC)、40wt%的碳酸二甲酯(DMC)、25wt%的碳酸甲乙酯(EMC)组成的混合溶剂中,并添加5wt%的氟代碳酸乙烯酯,得到锂离子电池电解液。

[0043] 锂离子电池的制备:在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕,制成卷芯;将卷芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

[0044] 实施例2

[0045] 正极片的制备:将磷酸铁锂、聚偏氟乙烯、导电石墨和碳纳米纤维按重量配比90:3.0:3.0:4.0混合,加入N-甲基吡咯烷酮溶剂进行搅拌,制成正极浆料,所得正极浆料的固含量为55%,然后涂覆在铝箔上进行烘干,烘干后进行辊压和分切操作,并在铝箔的中部焊接正极耳,制成压实密度为 $3.5\text{g}/\text{cm}^3$ 的正极片。

[0046] 负极片的制备:将石墨、羧甲基纤维素钠、丁苯橡胶、碳纳米管按重量配比90:3.5:3.0:3.5混合,加入水溶剂进行搅拌,制成负极浆料,所得负极浆料的固含量为50%,然后涂覆在铜箔上进行烘干,烘干后进行辊压和分切操作,并在铜箔的两端焊接负极耳,制成压实密度为 $1.55\text{g}/\text{cm}^3$ 的负极片。

[0047] 隔离膜的制备:将氟乙烯类共聚物溶解在丙酮溶剂中,然后涂覆在聚丙烯膜表面,制成厚度为 $10\mu\text{m}$,孔隙率为40%的聚合物多孔膜。

[0048] 电解液的制备:将5wt%的双三氟甲烷磺酰亚胺锂溶解于25wt%的碳酸乙烯酯(EC)、35wt%的碳酸二甲酯(DMC)、25wt%的碳酸甲乙酯(EMC)组成的混合溶剂中,并添加10wt%的1,3-丙烷磺酸内酯,得到锂离子电池电解液。

[0049] 锂离子电池的制备:在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕,制成卷芯;将卷芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

[0050] 实施例3

[0051] 正极片的制备:将 $\text{LiNi}_{0.5}\text{Co}_{0.2}\text{Mn}_{0.3}\text{O}_2$ 、聚偏氟乙烯、石墨烯按重量配比99:0.5:0.5混合,加入N-甲基吡咯烷酮溶剂进行搅拌,制成正极浆料,所得正极浆料的固含量为65%,然后涂覆在铝箔上进行烘干,烘干后进行辊压和分切操作,并在铝箔的中部焊接正极耳,制成压实密度为 $4.2\text{g}/\text{cm}^3$ 的正极片。

[0052] 负极片的制备:将石墨、羧甲基纤维素钠、丁苯橡胶、科琴黑按重量配比98:0.5:1.0:0.5混合,加入水溶剂进行搅拌,制成负极浆料,所得负极浆料的固含量为60%,然后涂覆在铜箔上进行烘干,烘干后进行辊压和分切操作,并在铜箔的两端焊接负极耳,制成压实密度为 $1.70\text{g}/\text{cm}^3$ 的负极片。

[0053] 隔离膜的制备:将氟乙烯类共聚物溶解在丙酮溶剂中,然后涂覆在聚酰亚胺膜表面,制成厚度为 $20\mu\text{m}$,孔隙率为50%的聚合物多孔膜。

[0054] 电解液的制备:将5wt%的双氟磺酰亚胺锂溶解于25wt%的碳酸丙稀酯(PC)、35wt%的碳酸二甲酯(DMC)、25wt%的碳酸甲乙酯(EMC)组成的混合溶剂中,并添加5wt%的1,4-丁烷磺酸内酯和5wt%的己二腈,得到锂离子电池电解液。

[0055] 锂离子电池的制备:在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕,制成卷芯;将卷芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

[0056] 实施例4

[0057] 正极片的制备:将 $\text{LiNi}_{0.5}\text{Co}_{0.2}\text{Mn}_{0.3}\text{O}_2$ 、聚偏氟乙烯、科琴黑按重量配比97.5:1.5:1.0混合,加入N-甲基吡咯烷酮溶剂进行搅拌,制成正极浆料,所得正极浆料的固含量为60%,然后涂覆在铝箔上进行烘干,烘干后进行辊压和分切操作,并在铝箔的中部焊接正极耳,制成压实密度为 $4.0\text{g}/\text{cm}^3$ 的正极片。

[0058] 负极片的制备:将石墨、羧甲基纤维素钠、丁苯橡胶、碳纳米纤维按重量配比96:1.0:1.5:1.5混合,加入水溶剂进行搅拌,制成负极浆料,所得负极浆料的固含量为55%,然后涂覆在铜箔上进行烘干,烘干后进行辊压和分切操作,并在铜箔的两端焊接负极耳,制成压实密度为 $1.65\text{g}/\text{cm}^3$ 的负极片。

[0059] 隔离膜的制备:将氟乙烯类共聚物溶解在丙酮溶剂中,然后涂覆在芳纶膜表面,制

成厚度为18 μm ,孔隙率为45%的聚合物多孔膜。

[0060] 电解液的制备:将8wt%的双氟磺酰亚胺锂溶解于25wt%的碳酸丙稀酯(PC)、35wt%的碳酸二甲酯(DMC)、25wt%的碳酸甲乙酯(EMC)组成的混合溶剂中,并添加4wt%的碳酸亚乙烯酯和3wt%的4-甲基硫酸乙烯酯,得到锂离子电池电解液。

[0061] 锂离子电池的制备:在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕,制成卷芯;将卷芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

[0062] 实施例5

[0063] 正极片的制备:将磷酸铁锂、聚偏氟乙烯、石墨烯按重量配比98:1.5:0.5混合,加入N-甲基吡咯烷酮溶剂进行搅拌,制成正极浆料,所得正极浆料的固含量为60%,然后涂覆在铝箔上进行烘干,烘干后进行辊压和分切操作,并在铝箔的中部焊接正极耳,制成压实密度为3.95g/cm³的正极片。

[0064] 负极片的制备:将石墨、羧甲基纤维素钠、丁苯橡胶、碳纳米管按重量配比95:1.5:2.0:1.5混合,加入水溶剂进行搅拌,制成负极浆料,所得负极浆料的固含量为55%,然后涂覆在铜箔上进行烘干,烘干后进行辊压和分切操作,并在铜箔的两端焊接负极耳,制成压实密度为1.68g/cm³的负极片。

[0065] 隔离膜的制备:将氟乙烯类共聚物溶解在丙酮溶剂中,然后涂覆在聚乙烯/聚丙烯复合膜表面,制成厚度为18 μm ,孔隙率为48%的聚合物多孔膜。

[0066] 电解液的制备:将10wt%的双氟磺酰亚胺锂溶解于25wt%的碳酸丙稀酯(PC)、35wt%的碳酸二甲酯(DMC)、25wt%的碳酸甲乙酯(EMC)组成的混合溶剂中,并添加2wt%的氟代碳酸亚乙烯酯和3wt%的硫酸乙烯酯,得到锂离子电池电解液。

[0067] 锂离子电池的制备:在制备好的正极片和负极片之间加入聚合物多孔膜进行卷绕,制成卷芯;将卷芯置于包装壳中,顶侧封后注入电解液,然后通过化成、夹具烘烤、二封和分容工序制成聚合物锂离子电池。

[0068] 分别对实施例1~5所制得的锂离子电池按标准工艺充放电,测试电池的充放电性能。并根据测试结果作图如图3~6所示。其中,对电池的倍率充电性能测试结果作图如图3所示,对电池的倍率放电性能测试结果作图如图4所示,对电池的快充时间电压测试结果作图如图5所示,对电池的低温放电性能测试结果作图如图6所示。

[0069] 测试结果表明上述方法制备的锂离子电池进行5C放电的容量保持率达97%以上,有效满足大倍率充放电要求;快充8.5min可充进70%左右,快充效果明显提高;进行-20℃/0.2C低温放电的容量保持率达86%以上,低温放电性能优异。

[0070] 根据上述说明书的揭示和教导,本发明所属领域的技术人员还能够对上述实施方式进行变更和修改。因此,本发明并不局限于上述的具体实施方式,凡是本领域技术人员在本发明的基础上所作出的任何显而易见的改进、替换或变型均属于本发明的保护范围。此外,尽管本说明书中使用了一些特定的术语,但这些术语只是为了方便说明,并不对本发明构成任何限制。

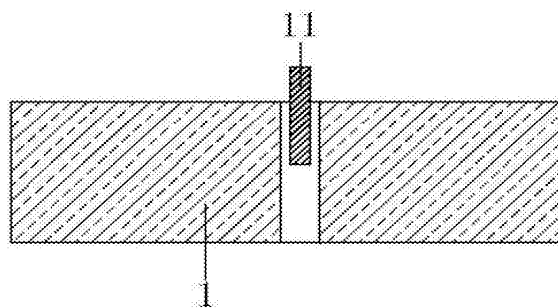


图1

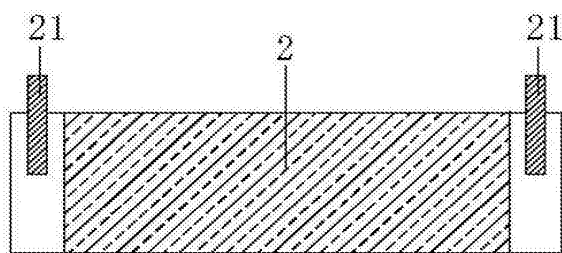


图2

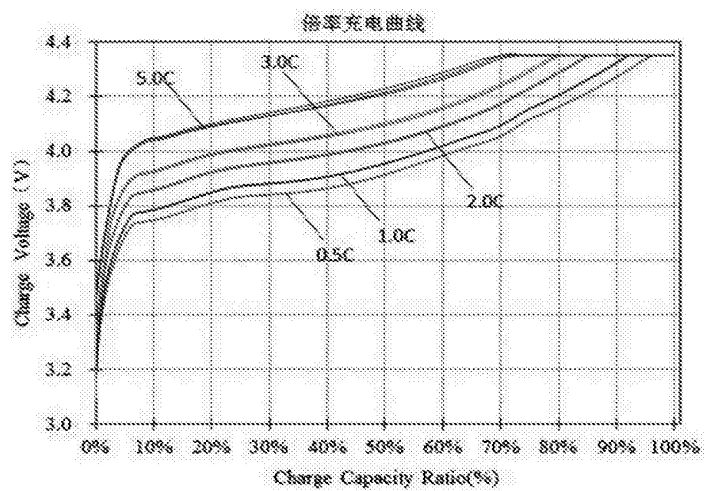


图3

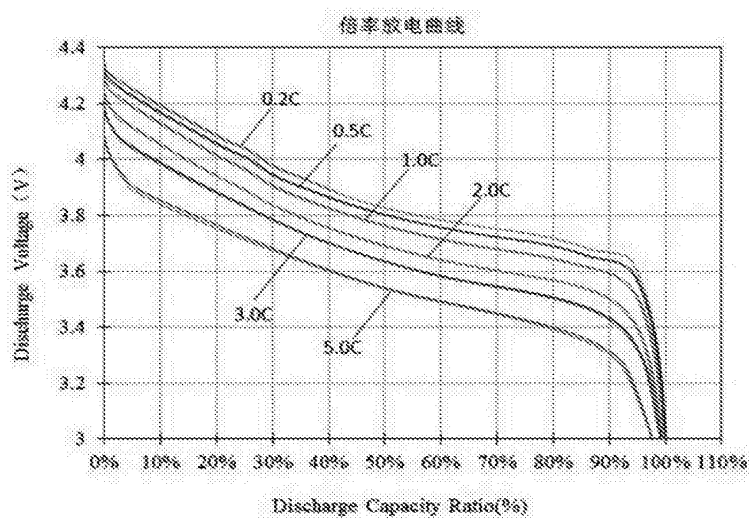


图4

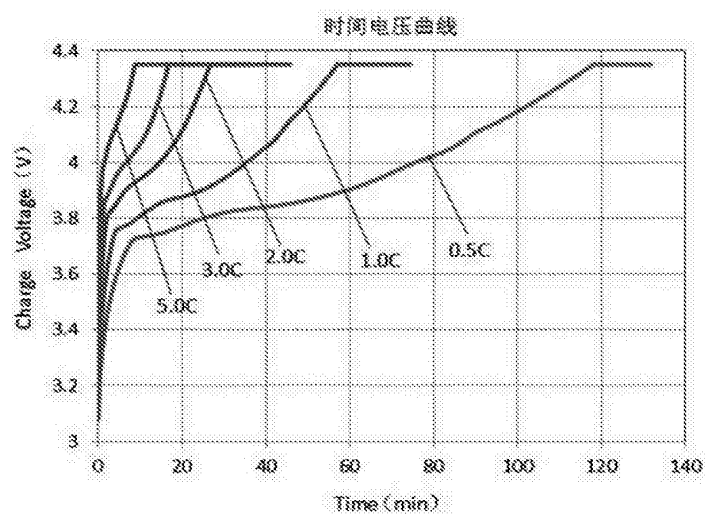


图5

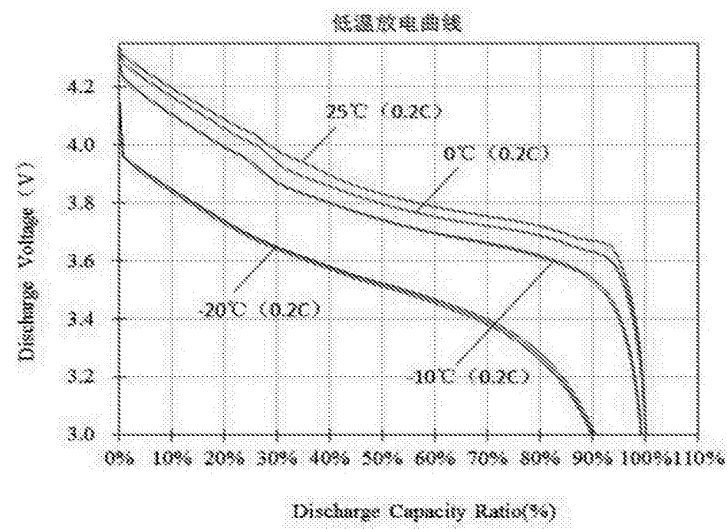


图6



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/211,853	12/06/2018	Kefei WANG	LEEL-0091	4935
38327	7590	05/26/2020	EXAMINER	
Juan Carlos A. Marquez			DOUYETTE, KENNETH J	
Marquez Intellectual Property Law Office PLLC			ART UNIT	
1629 K Street, NW			PAPER NUMBER	
Suite 300			1725	
Washington, DC 20006			NOTIFICATION DATE	
			DELIVERY MODE	
			05/26/2020	
			ELECTRONIC	

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USPTO@dockettrak.com
lniu@marqueziplaw.com
mail@marqueziplaw.com

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1-17 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.
3. Claim 1 recites the limitations "the total weight of the electrolyte" in line 2. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the total weight of the electrolyte" will be interpreted as "a total weight of the electrolyte". Further, claims 2-13 are rejected since they depend from claim 1.
4. Claim 1 recites the limitations "the weight percentage of the dinitrile compound" and "the weight percentage of the trinitrile compound" in lines 2-4. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the weight percentage of the trinitrile compound" will be interpreted as "a weight percentage of the trinitrile compound" and "the weight percentage of the dinitrile compound" will be interpreted as "a weight percentage of the dinitrile compound". Further, claims 2-13 are rejected since they depend from claim 1.

5. Claim 1 recites the limitation "the conditions" in line 4. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the conditions" will be interpreted as "conditions". Further, claims 2-13 are rejected since they depend from claim 1.

6. Claims 14 and 17, each independent claims, are also rejected for insufficient antecedent basis in the claims since each includes the same terms as listed in points 3-5 above. And, claims 15-16 are rejected since they depend from claim 14.

7. Claim 2 recites the limitation "the condition" in line 3. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the condition" will be interpreted as "a condition".

8. Claim 7 recites the limitation "the weight percentage Z" in line 2. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the weight percentage Z" will be interpreted as "a weight percentage Z".

9. Claim 10 recites the limitation "the fluoroether" in line 1. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the fluorether" will be interpreted as "a fluoroether". Further, if one of Formula 8, 9, 10, or 11 is a fluoroether, claim 10 could be corrected and thus not rejected under 112 by stating which formula number the fluoroether is.

10. Claim 11 recites the limitation "the content of cyclic phosphonic anhydride" in lines 2-3. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the content of cyclic phosphonic anhydride" will be interpreted as "a content of cyclic phosphonic anhydride".

11. Claim 12 recites the limitation "the group consisting of" in lines 2-3. There is insufficient antecedent basis for this limitation in the claim. For the purposes of this office action, "the group consisting of" will be interpreted as "a group consisting of".

12. A broad range or limitation together with a narrow range or limitation that falls within the broad range or limitation (in the same claim) is considered indefinite, since the resulting claim does not clearly set forth the metes and bounds of the patent protection desired. See MPEP § 2173.05(c). Note the explanation given by the Board of Patent Appeals and Interferences in *Ex parte Wu*, 10 USPQ2d 2031, 2033 (Bd. Pat. App. & Inter. 1989), as to where broad language is followed by "such as" and then narrow language. The Board stated that this can render a claim indefinite by raising a question or doubt as to whether the feature introduced by such language is (a) merely exemplary of the remainder of the claim, and therefore not required, or (b) a required feature of the claims. Note also, for example, the decisions of *Ex parte Steigewald*, 131 USPQ 74 (Bd. App. 1961); *Ex parte Hall*, 83 USPQ 38 (Bd. App. 1948); and *Ex parte Hasche*, 86 USPQ 481 (Bd. App. 1949). In the present instance, claim 15 recites the broad recitation "a coating" having three options, single-sided coating, double-sided coating, or a combination thereof, and the claim also recites a configuration naming

"D1" and "D2" in a relationship specified in lines 8-10, illustrating a specific instance with a combination of single-sided and double-sided coating (i.e. "a combination thereof" in line 3) which is the narrower statement of the range/limitation. For the purposes of this office action, claim 15 will be examined with the wider scope of lines 1-3 (thus only a single-sided coating reads on the limitations of the claim). Further, claim 16 is rejected since it depends from claim 15.

Claim Rejections - 35 USC § 103

13. The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

14. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating

obviousness or nonobviousness.

15. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was

commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

16. Claims 1-4, 7-10, 12 and 14-17 are rejected under 35 U.S.C. 103 as being unpatentable over Ohashi (US 2017/0324116).

Regarding claim 1, Ohashi discloses an electrolyte ([0002]) a dinitrile compound ([0070]-[0071]), a trinitrile compound ([0070]-[0071]), and propyl propionate ([0134]), with a total amount of the dinitrile and trinitrile compounds is 5% ([0072]). The reference does not explicitly disclose the amount of dinitrile/trinitrile is between about 0.1 - 8. As the battery cycle characteristics and resistance are variables that can be modified, among others, by adjusting said amount of dinitrile/trinitrile, with said cycle characteristics and resistance both varying as the amount of dinitrile/trinitrile is varied, the precise amount of dinitrile/trinitrile would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was filed. As such, without showing unexpected results, the claimed amount of dinitrile/trinitrile cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was filed would have optimized, by routine experimentation, the amount of dinitrile/trinitrile in the electrolyte of Ohashi to obtain the desired balance between the cycle characteristics and resistance (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that where the general conditions of the claim are

disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

Regarding claim 2, Ohashi discloses all of the claim limitations as set forth above. While the reference does not explicitly disclose the amount of trinitrile/propyl propionate is about 0.01 - 3, the variation in the amount of trinitrile/propyl propionate is not considered to confer patentability to the claims. Ohashi (see [0134]) teaches that it was known in the art at the time of the invention that varying the amount of trinitrile/propyl propionate will vary the performance characteristics of the battery. Therefore the performance characteristics of the battery is/are a variable(s) that can be modified, among others, by varying the amount of trinitrile/propyl propionate. For that reason, the amount of trinitrile/propyl propionate, would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was filed. As such, without showing unexpected results, the amount of trinitrile/propyl propionate cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was filed would have optimized, by routine experimentation, the amount of trinitrile/propyl propionate in the electrolyte of Ohashi to obtain the desired performance characteristics of the battery (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

Regarding claims 3 and 4, Ohashi discloses all of the claim limitations as set forth above and also discloses the dinirile compound is glutaronitrile or adiponitrile ([0069]-[0071]).

Regarding claim 7, Ohashi discloses all of the claim limitations as set forth above and also discloses either or both of X and Y is about 4 wt%, but does not explicitly disclose weight percentage Z is about 5 – 50 wt%. However, the amount of propyl propionate is not considered to confer patentability to the claims. Ohashi (see [0134]) teaches that it was known in the art at the time of the invention that varying the amount of propyl propionate will vary the performance characteristics of the battery. Therefore the performance characteristics of the battery is/are a variable(s) that can be modified, among others, by varying the amount of propyl propionate. For that reason, the amount of propyl propionate, would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was filed. As such, without showing unexpected results, the amount of propyl propionate cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was filed would have optimized, by routine experimentation, the amount of propyl propionate in the electrolyte of Ohashi to obtain the desired performance characteristics of the battery (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

Regarding claims 8-10, Ohashi discloses all of the claim limitations as set forth above and also discloses a fluoroether comprising 1,1,2,2-tetrafluoroethyl-2,2,3,3-tetrafluoropropyl ether ([0136]).

Regarding claims 12, Ohashi discloses all of the claim limitations as set forth above and also discloses a compound having a sulfur-oxygen double bond ([0073]-[0074]).

Regarding claim 14, Ohashi discloses an electrochemical device (Abstract, [0011]), wherein the electrochemical device comprises electrodes (Abstract, [0011]) and an electrolyte ([0002]), the electrolyte ([0002]) comprising a dinitrile compound ([0070]-[0071]), a trinitrile compound ([0070]-[0071]), and propyl propionate ([0134]), with a total amount of the dinitrile and trinitrile compounds is 5% ([0072]). The reference does not explicitly disclose the amount of dinitrile/trinitrile is between about 0.1 - 8. As the battery cycle characteristics and resistance are variables that can be modified, among others, by adjusting said amount of dinitrile/trinitrile, with said cycle characteristics and resistance both varying as the amount of dinitrile/trinitrile is varied, the precise amount of dinitrile/trinitrile would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was filed. As such, without showing unexpected results, the claimed amount of dinitrile/trinitrile cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was filed would have optimized, by routine experimentation, the amount of dinitrile/trinitrile in the electrolyte of Ohashi to obtain the desired balance between the cycle characteristics and resistance (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that

where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

Regarding claim 15, Ohashi discloses all of the claim limitations as set forth above and also discloses the electrode comprises a current collector ([0181]) and a coating on the current collector ([0181]), the collector comprising a single-sided coating formed by applying a slurry ([0179], [0214], [0218]) on one surface of the current collector and having a compaction density D1 ([0179], [0181], [0217], [0218]).

Regarding claim 16, Ohashi discloses all of the claim limitations as set forth above and also discloses the electrodes comprise a cathode ([0217]) and an anode ([0181]), cathode 4.2 g/cm³ ([0217]) and anode 1.3 g/cm³ ([0181]).

Regarding claim 17, Ohashi discloses an electronic device ([0003], [0266]), comprising an electrochemical device (Abstract, [0011]), wherein the electrochemical device comprises electrodes (Abstract, [0011]) and an electrolyte ([0002]), the electrolyte ([0002]) comprising a dinitrile compound ([0070]-[0071]), a trinitrile compound ([0070]-[0071]), and propyl propionate ([0134]), with a total amount of the dinitrile and trinitrile compounds is 5% ([0072]). The reference does not explicitly disclose the amount of dinitrile/trinitrile is between about 0.1 - 8. As the battery cycle characteristics and resistance are variables that can be modified, among others, by adjusting said amount of dinitrile/trinitrile, with said cycle characteristics and resistance

both varying as the amount of dinitrile/trinitrile is varied, the precise amount of dinitrile/trinitrile would have been considered a result effective variable by one having ordinary skill in the art at the time the invention was filed. As such, without showing unexpected results, the claimed amount of dinitrile/trinitrile cannot be considered critical. Accordingly, one of ordinary skill in the art at the time the invention was filed would have optimized, by routine experimentation, the amount of dinitrile/trinitrile in the electrolyte of Ohashi to obtain the desired balance between the cycle characteristics and resistance (*In re Boesch*, 617 F.2d. 272, 205 USPQ 215 (CCPA 1980)), since it has been held that where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. (*In re Aller*, 105 USPQ 223).

17. Claims 5, 6 and 13 are rejected under 35 U.S.C. 103 as being unpatentable over Ohashi (US 2017/0324116) as applied to claim 1 above, and further in view of Kim et al. (US 2017/0069934).

Regarding claims 5 and 6, Ohashi discloses all of the claim limitations as set forth above but does not explicitly disclose 1,3,5-pentanetricarbonitrile and gamma-butyrolactone or gamma-valerolactone.

Kim et al. discloses in Figs 1-8, a battery (ref 100) including an electrolyte ([0030]) comprising 1,3,5-pentanetricarbonitrile ([0038]) and gamma-butyrolactone or gamma-valerolactone ([0038], all listed). Adding these compounds enhances battery capacity and cycle life ([0038]).

Kim et al. and Ohashi are analogous since both deal in the same field of endeavor, namely, battery electrolytes.

It would have been obvious to one of ordinary skill in the art at the time of filing to incorporate the 1,3,5-pentanetricarbonitrile and gamma-butyrolactone or gamma-valerolactone disclosed by Kim et al. into the electrolyte of Ohashi to enhance capacity and cycle life, thereby enhancing overall battery performance.

18. Claim 11 is rejected under 35 U.S.C. 103 as being unpatentable over Ohashi (US 2017/0324116) as applied to claim 1 above, and further in view of Zhang et al. (US 2017/0317385).

Regarding claim 11, Ohashi discloses all of the claim limitations as set forth above but does not explicitly disclose a cyclic phosphonic anhydride at 0.01 – 10 wt%.

Zhang et al. discloses a battery ([0008]) including an electrolyte ([0008]) comprising a cyclic phosphonic anhydride ([0043]) at 0.05 – 10 wt% ([0089]). Adding these compounds enhances battery stability and cycle life ([0090], [0101], [0103], [0114], [0115]).

Zhang et al. and Ohashi are analogous since both deal in the same field of endeavor, namely, battery electrolytes.

It would have been obvious to one of ordinary skill in the art at the time of filing to incorporate the amount of cyclic phosphonic anhydride disclosed by Zhang et al. into the electrolyte of Ohashi to enhance battery stability and cycle life, thereby enhancing overall battery performance.

Conclusion

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to KENNETH J DOUYETTE whose telephone number is (571)270-1212. The examiner can normally be reached on Monday - Friday 8A - 4P EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/KENNETH J DOUYETTE/
Primary Examiner, Art Unit 1725

<i>Notice of References Cited</i>	Application/Control No. 16/211,853		Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner KENNETH J DOUYETTE		Art Unit 1725	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20170324116-A1	11-2017	OHASHI; Youichi	H01M10/0567	1/1
*	B	US-20170069934-A1	03-2017	KIM; Yun-Hee	H01M10/0567	1/1
*	C	US-20170317385-A1	11-2017	Zhang; Zhenghua	H01M10/0568	1/1
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
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	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20200423

<i>Search Notes</i> 	Application/Control No. 16/211,853	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner KENNETH J DOUYETTE	Art Unit 1725

CPC - Searched*		
Symbol	Date	Examiner
H01M 10/05, 10/0566, 10/0545	05/20/2020	KD

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
PALM inventor database search	05/20/2020	KD
EAST text search, see search history	05/20/2020	KD

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

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EAST Search History**EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	h01m\$.cpc. and battery and propyl adj propionate same dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 12:50
L2	10	h01m\$.cpc. and battery and propyl adj propionate and dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 12:50
L3	2	"20170018803" and propionate	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 12:57
L4	2	"20160294007" and propionate	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 12:57
L5	814	h01m\$.cpc. and battery and propyl adj propionate	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 12:58
L6	5	h01m\$.cpc. and battery and dinitrile same trinitrile same ratio	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 13:05
L7	23	h01m\$.cpc. and battery and dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 13:07
L8	4	h01m\$.cpc. and battery and dinitrile same trinitrile same amount	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 13:09
L9	0	("2017/0324116").URPN.	USPAT	OR	OFF	2020/04/23 14:09
L10	1	"20170324116"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 14:40
L11	0	"20170324116" and fluoroether	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 14:40

L12	1	"20170324116" and ether	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 14:40
L13	1	"20200099098" and fluoroether	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 14:56
L14	2	h01m\$.cpc. and battery and fepe	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 14:57
L15	20	battery and fepe	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 14:57
L16	1	"20170324116" and anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:15
L17	1	"20200099098" and anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:16
L18	2	h01m\$.cpc. and battery and ("te3p" "tm3p" "t3p")	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:22
L19	105	battery and ("te3p" "tm3p" "t3p")	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:22
L20	1	"20170324116" and ester	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:24
L21	0	"20170324116" and (butyrolacetone valerolacetone)	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:29
L22	1	"20170324116" and acetone	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:29
L23	1	"20170324116" and collector	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:30

L24	1	"20170324116" and positive	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:31
L25	1	"20170324116" and density	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 15:41
L26	186	h01m\$.cpc. and battery and (pentanetricarbonitrile propanetrinitrile hexanetricarbonitrile)	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:05
L27	3	h01m\$.cpc. and battery and ("5" "3" "6") near2 (pentanetricarbonitrile propanetrinitrile hexanetricarbonitrile)	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:06
L28	2	h01m\$.cpc. and battery and cyclic adj phosphonic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:23
L29	2	battery and cyclic adj phosphonic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:23
L30	18	cyclic adj phosphonic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:23
L31	2	cyclic adj phosphonic adj anhydride same electrolyte	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:23
L32	27	battery and ("te3p" "tm3p" "t3p") same anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:24
L33	1	"2020099098" and ("te3p" "tm3p" "t3p")	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:28
L34	1	h01m\$.cpc. and battery and (propylphosphonic methylphosphonic ethylphosphonic) adj cyclic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:31
L35	1	battery and (propylphosphonic methylphosphonic ethylphosphonic) adj cyclic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:31

L36	40	(propylphosphonic methylphosphonic ethylphosphonic) adj cyclic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:31
L37	0	(propylphosphonic methylphosphonic ethylphosphonic) adj cyclic adj anhydride same electrolyte	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:32
L38	1	(propylphosphonic methylphosphonic ethylphosphonic) adj cyclic adj anhydride and electrolyte	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:32
L39	0	h01m\$.cpc. and battery and (propyl methyl ethyl) adj phosphonic adj cyclic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:32
L40	0	h01m\$.cpc. and battery and (propyl methyl ethyl) same phosphonic adj cyclic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:33
L41	0	h01m\$.cpc. and battery and phosphonic adj cyclic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:33
L42	0	h01m\$.cpc. and battery and (propyl methyl ethyl) adj phosphonic adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:34
L43	0	h01m\$.cpc. and battery and (propyl methyl ethyl) adj phosphonic near2 anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:34
L44	2	h01m\$.cpc. and battery and (propylphosphonic methylphosphonic ethylphosphonic) adj anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:34
L45	1	"20170317385" and anhydride	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 16:43
S58	1	"20200099098"	DERWENT	OR	ON	2020/04/23 10:16
S59	1	2019-14501J.NRAN.	DERWENT	OR	OFF	2020/04/23 10:16
S60	1	"9812739".pn.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:18

S61	2	"20160294007"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:19
S62	2	"20160294007" and trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:19
S63	2	"20170288268"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:21
S64	0	"20170288268" and trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:22
S65	0	"20170288268" and dinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:22
S66	0	"2017018803"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:42
S67	2	"20170018803"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/23 10:42

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Doc description: Information Disclosure Statement (IDS) Filed

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	Filing Date	2018-12-06
	First Named Inventor	Kefei WANG
	Art Unit	1725
	Examiner Name	Basia Anna RIDLEY
	Attorney Docket Number	LEEL-0091

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/K.J.D/	1	106816633	CN	A	2017-06-09	University of Jiliang, China	English abstract	×
/K.J.D/	2	2017022108	JP	A	2017-01-26	Stella Chemifa Corp.	English abstract	☒

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	Art Unit	1725
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	Attorney Docket Number	LEEL-0091

/K.J.D/	3	105680088	CN	A	2016-06-15	Donguan Kaixin Battery Material Co., Ltd.	English abstract	☒
/K.J.D/	4	103401020	CN	A	2013-11-20	Dongguan Shanshan Battery Materials Co., Ltd.	English abstract	☒
/K.J.D/	5	103779607	CN	A	2014-05-07	Central South University	English abstract	☒
/K.J.D/	6	104752769A	CN	A	2015-07-01	Ningde Amperex Technology Ltd.	English abstract	☒
/K.J.D/	7	106099185	CN	A	2016-11-09	Highpower Tech (Huizhou) Co., Ltd.	English abstract	☒
/K.J.D/	8	104979589	CN	A	2015-10-14	Donguan Kaixin Battery Material Co., Ltd.	English abstract	☒
/K.J.D/	9	103956517	CN	A	2014-07-30	South China Normal University	English abstract	☒
/K.J.D/	10	105098237	CN	A	2015-11-25	Zhejiang Research Inst. of Chemical Industry Ltd.	English abstract	☒
/K.J.D/	11	105355975	CN	A	2016-02-24	Ningde Amperex Technology Ltd.	English abstract	☒
/K.J.D/	12	105529498	CN	A	2016-04-27	Donguan Kaixin Battery Material Co., Ltd.	English abstract	☐
/K.J.D/	13	107394269	CN	A	2017-11-24	Ningde Amperex Technology Ltd.	English abstract	☒

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	Examiner Name	Basia Anna RIDLEY		
Attorney Docket Number		LEEL-0091		

/K.J.D/	14	108242567	CN	A	2018-07-03	Ningde Ccomptemporary Amperex Technology Co., Ltd.	English abstract	☒
/K.J.D/	15	107275553	CN	A	2017-10-20	Dongguan Liwinon Energy Tech Co., Ltd.	English abstract	☒

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/K.J.D/	1	Extended European Search Report issued January 14, 2020 in European application 19198416.0, 7 pages in English	☒
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	Examiner Name	Basia Anna RIDLEY
	Attorney Docket Number	LEEL-0091

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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Signature	/Juan.carlos.a.marquez/	Date (YYYY-MM-DD)	2020-04-14
Name/Print	Juan Carlos A. Marquez	Registration Number	34072

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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	First Named Inventor	Kefei WANG
	Art Unit	
	Examiner Name	
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/K.J.D/	2	101640290	CN	A	2010-02-03	Sanyo Electric Co.	English Abstract	☒
/K.J.D/	3	103928708	CN	A	2014-07-16	Samsung SDI Co., Ltd.	English Abstract	☒

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Name/Print	Juan Carlos A. Marquez	Registration Number	34072

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/K.J.D/	2	20180233778	A1	2018-08-16	Park et al.		
/K.J.D/	3	20180108947	A9	2018-04-19	Zhuang		
/K.J.D/	4	20160301103	A1	2016-10-13	Kim et al.		
/K.J.D/	5	20140322596	A1	2014-10-30	Shatunov et al.		

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	Examiner Name	Basia Anna RIDLEY		
	Attorney Docket Number	LEEL-0091		

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/K.J.D/	1	109301326	CN	A	2019-02-01	Ningde Amperex Technology Ltd.	English abstract	×
/K.J.D/	2	101195931	KR	B1	2012-12-30	LG Chemical Ltd.	English abstract	☒
/K.J.D/	3	103633371	CN	A	2014-03-12	Shenzhen Capchem Technology Co., Ltd.	English abstract	☒
/K.J.D/	4	104332653	CN	A	2015-02-04	Amperex Technology Ltd.	English abstract	☒
/K.J.D/	5	102522590	CN	A	2012-06-27	Huawei Tech Co., Ltd.	English abstract	☒
/K.J.D/	6	105609874	CN	A	2016-05-25	Dongguan Amperex Technology Ltd.	English abstract	☒
/K.J.D/	7	103682416	CN	B	2014-03-26	Samsung SDI Co., Ltd.	English abstract	☒
/K.J.D/	8	107408734	CN	A	2017-11-28	Mitsubishi Chem Corp.	English abstract	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16211853	
	Filing Date		2018-12-06	
	First Named Inventor	Kefei WANG		
	Art Unit	1725		
	Examiner Name	Basia Anna RIDLEY		
	Attorney Docket Number	LEEL-0091		

/K.J.D/	9	105355968	CN	A	2016-02-24	Ningde Amperex Technology Ltd.	English abstract	☒
/K.J.D/	10	104766995	CN	A	2015-07-08	Ningde Amperex Technology Ltd.	English abstract	☒
/K.J.D/	11	105895957	CN	A	2016-08-24	Contemporary Amperex Technology Co., Ltd.	English abstract	☒
/K.J.D/	12	106784589	CN	A	2017-05-31	Ningde Contemporary Amperex Tech Co., Ltd.	English abstract	☒
/K.J.D/	13	103348516	CN	A	2013-10-09	Sanyo Electric Co.	English abstract	☒
/K.J.D/	14	102244294	CN	A	2011-11-16	Mitsubishi Chem Corp.	English abstract	☒
/K.J.D/	15	106654128	CN	A	2017-05-10	Ningde Amperex Technology Ltd.	English abstract	☒
/K.J.D/	16	20170051286	KR	A	2017-05-11	LG Chemical Ltd.	English abstract	☒

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16211853
	Filing Date	2018-12-06
	First Named Inventor	Kefei WANG
	Art Unit	1725
	Examiner Name	Basia Anna RIDLEY
	Attorney Docket Number	LEEL-0091

EXAMINER SIGNATURE			
Examiner Signature	/KENNETH J DOUYETTE/	Date Considered	04/23/2020
*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.			
¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.			

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16211853
	Filing Date	2018-12-06
	First Named Inventor	Kefei WANG
	Art Unit	1725
	Examiner Name	Basia Anna RIDLEY
	Attorney Docket Number	LEEL-0091

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Juan.carlos.a.marquez/	Date (YYYY-MM-DD)	2020-03-04
Name/Print	Juan Carlos A. Marquez	Registration Number	34072

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
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BIB DATA SHEET

CONFIRMATION NO. 4935

SERIAL NUMBER 16/211,853	FILING or 371(c) DATE 12/06/2018 RULE	CLASS 429	GROUP ART UNIT 1725	ATTORNEY DOCKET NO. LEEL-0091		
APPLICANTS NINGDE AMPEREX TECHNOLOGY LIMITED, Ningde City, CHINA; INVENTORS Kefei WANG, Ningde City, CHINA; Qiao ZENG, Ningde City, CHINA; Liangzhen XIAO, Ningde City, CHINA; Fei WU, Ningde City, CHINA; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** CHINA 201811108529.X 09/21/2018 ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 12/31/2018						
Foreign Priority claimed ☒ Yes ☐ No	35 USC 119(a-d) conditions met ☒ Yes ☐ No	☐ Met after Allowance	STATE OR COUNTRY CHINA	SHEETS DRAWINGS 3	TOTAL CLAIMS 17	INDEPENDENT CLAIMS 3
Verified and Acknowledged	/KENNETH J DOUYETTE/ Examiner's Signature	Initials				
ADDRESS Juan Carlos A. Marquez Marquez Intellectual Property Law Office PLLC 1629 K Street, NW Suite 300 Washington, DC 20006 UNITED STATES						
TITLE ELECTROLYTE AND ELECTROCHEMICAL DEVICE						
FILING FEE RECEIVED 1720	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit			

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Application	Document	Mailroom Date	Attorney Docket No.
16211853	CTNF	05/26/2020	LEEL-0091
	892	05/26/2020	LEEL-0091
	1449	05/26/2020	LEEL-0091
	1449	05/26/2020	LEEL-0091
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PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

Electronic Acknowledgement Receipt	
EFS ID:	40376986
Application Number:	16211853
International Application Number:	
Confirmation Number:	4935
Title of Invention:	ELECTROLYTE AND ELECTROCHEMICAL DEVICE
First Named Inventor/Applicant Name:	Kefei WANG
Customer Number:	38327
Filer:	Juan Carlos A. Marquez
Filer Authorized By:	
Attorney Docket Number:	LEEL-0091
Receipt Date:	25-AUG-2020
Filing Date:	06-DEC-2018
Time Stamp:	15:02:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	LEEL-91_Claim_calculation_Response_OA_05262020.pdf	212704 66e0bd3abf636b7e6cfa067493ed9f8f6b28f31f	no	2

Warnings:

Information:					
2	Amendment/Req. Reconsideration-After Non-Final Reject	LEEL-91_Response_OA_052620 20.pdf	327021	no	11
			cf4e03c89e1ad0dd1fcc9fb7996804d50d86 ff80		
Warnings:					
Information:					
			Total Files Size (in bytes):		
			539725		
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. Patent Application of	)	Confirmation No. 4935
	)	
WANG et al.	)	
	)	Art Unit 1725
Application Number: 16/211,853	)	
	)	
Filed: December 6, 2018	)	Examiner:
	)	Kenneth J. Douyette
For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE	)	
	)	
Attorney Docket No. LEEL-0091	)	

**Mail Stop Amendment
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450**

COVER LETTER

Sir:

[x] The fee for submission of claims is calculated as shown below:

FOR	TOTAL WITH NEW CLAIMS ADDED	TOTAL CURRENTLY ON FILE	CLAIMS ALREADY PAID	RATE	CALCULATION
Total Claims	16	17	(Over 20)	x \$100	0
Independent Claims	3	3	(Over 3)	x \$460	0
Multiple Dependent Claim(s)				+ \$820	0
REDUCTION FOR FILING BY SMALL ENTITY (note 37 C.F.R. §§ 1.9, 1.27, 1.28).				x ½	
			TOTAL		\$0

In addition, the below-identified communications are submitted in the above-captioned application or proceeding:

☐ ☒	Response to Non-Final Office Action (with claim amendments and arguments)	☐	Information Disclosure Statement
☐	Terminal Disclaimer	☐	____ sheet of replacement drawings
		☐	Other:

☐ Applicant(s) hereby request and petition that the time for taking action in this case be extended pursuant to 37 C.F.R. § 1.136(a) for:

☐ **one (1) month** ☐ **two (2) months** ☐ **three (3) months**

The fee set in 37 C.F.R. § 1.17 for the extension of time is \$_____ for a large/small entity.

☐ Payment of \$_____ is made by Deposit Account via the EFS payment system.

☒ The Commissioner is hereby authorized to charge any additional fees associated with this communication, including fees under 37 C.F.R. § 1.16 and 1.17, or credit any overpayment to **Deposit Account Number 60-0155**.

Respectfully submitted,

/juan.carlos.a.marquez/

Juan Carlos A. Marquez
Registration Number 34,072

Marquez IP Law Office, PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006
Voice: (202) 349-1690
Fax: (202) 754-9829
Customer No. 38327

August 25, 2020

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. Patent Application of	)	Confirmation No. 4935
WANG et al.	)	
Application Number: 16/211,853	)	Art Unit 1725
Filed: December 6, 2018	)	
For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE	)	Examiner:
Attorney Docket No. LEEL-0091	)	Kenneth J. Douyette

Mail Stop Amendment
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE AND AMENDMENT UNDER 37 C.F.R. § 1.111

Sir:

This is in response to the Office Action mailed on May 26, 2020, the period of response to which is set to expire on August 26, 2020. Please amend and reconsider the above-referenced application as follows:

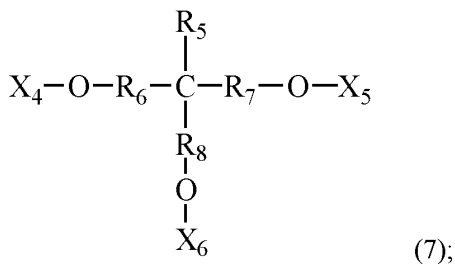
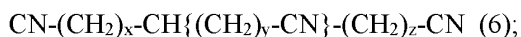
IN THE CLAIMS:

Claims 1 and 3-17 stand for consideration in this application, wherein claims 1, 7, 12 and 15 are being amended to more particularly point out and distinctly claim the subject invention; and claim 2 is being canceled without prejudice or disclaimer, all as follows:

1. (Currently Amended) An electrolyte, comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on [[the]] a total weight of the electrolyte, [[the]] a weight percentage of the dinitrile compound is X and [[the]] a weight percentage of the trinitrile compound is Y, where X and Y meet [[the]] conditions represented by Formula (1) and Formula (2):
about $2 \text{ wt}\% \leq (X+Y) \leq \text{about } 11 \text{ wt}\%$... (1); and
about $0.1 \leq (X/Y) \leq \text{about } 8$... (2);
wherein, based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z, where Y and Z meet a condition represented by Formula (3):
about $0.01 \leq (Y/Z) \leq \text{about } 0.3$... (3).
2. (Canceled).
3. (Original) The electrolyte according to Claim 1, wherein the dinitrile compound comprises a compound of Formula (4) or (5):
 $\text{CN-R}_1\text{-CN}$ (4);
 $\text{CN-R}_2\text{-(O-R}_3\text{)}_n\text{-O-R}_4\text{-CN}$ (5);
or a combination thereof,
where R_1 , R_2 , R_3 and R_4 are each independently an alkylene group having 1-5 carbon atoms or an alkenylene group having 2-5 carbon atoms,
and n represents an integer from 0 to 5.
4. (Original) The electrolyte according to Claim 1, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-

dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

5. (Original) The electrolyte according to Claim 1, wherein the trinitrile compound comprises a compound of Formula (6) or (7):



or a combination thereof,

where in Formula (6), x, y, and z represent an integer from 0 to 5, and x, y, and z are not 0 at the same time; and

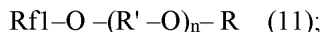
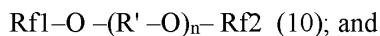
in Formula (7), R₅ represents hydrogen or an alkyl group having 1-5 carbon atoms, R₆, R₇ and R₈ are each independently an alkylene group having 1-5 carbon atoms, and X₄, X₅ and X₆ are each independently -R₉-CN, in which R₉ represents an alkylene group having 1-5 carbon atoms.

6. (Original) The electrolyte according to Claim 1, wherein the trinitrile compound is one

selected from the group consisting of: 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

7. (Currently Amended) The electrolyte according to Claim 1, wherein X is about 0.01-10 wt%, Y is about 0.01-10 wt%, and [[the]] a weight percentage Z of the propyl propionate is about 5-50 wt%.

8. (Original) The electrolyte according to Claim 1, further comprising a fluoroether comprising at least one of the compounds of Formula (8), Formula (9), Formula (10) or Formula (11):



wherein Formulae (8), (9), (10), and (11), Rf1 and Rf2 are each independently a linear or branched C₁ to C₁₂ fluoroalkyl group having at least one hydrogen atom substituted with fluoro, R is a linear or branched C₁ to C₁₂ alkyl group, and R' is a linear or branched C₁ to C₅ alkylene group, and n is an integer from 1 to 5.

9. (Original) The electrolyte according to Claim 8, wherein Rf1 or Rf2 is each independently a fluoroalkyl group selected from the group consisting of HCF₂-, CF₃-, HCF₂CF₂-, CH₃CF₂-, CF₃CH₂-, CF₃CF₂-, (CF₃)₂CH-, HCF₂CF₂CH₂-, CF₃CH₂CH₂-, HCF₂CF₂CF₂CH₂-, HCF₂CF₂CF₂CF₂CH₂-, CF₃CF₂CH₂-, CF₃CFHCF₂CH₂-, HCF₂CF(CF₃)CH₂-, and CF₃CF₂CH₂CH₂-.

10. (Original) The electrolyte according to Claim 8, wherein the fluoroether is one selected from the group consisting of: HCF₂CF₂CH₂OCF₂CF₂H, (CF₃)₂CFCF(CF₂CF₃)(OCH₃),

CF₃CHFCF₂CH(CH₃)OCF₂CHFCF₃, HCF₂CF₂CH₂OCF₂CF₂CF₂CF₂H,
HCF₂CF₂OCH₂CF₃, HCF₂CF₂OCH₂CH₂OCF₂CF₂H, HCF₂CF₂OCH₂CH₂CH₂OCF₂CF₂H,
HCF₂CF₂CH₂OCF₂CF₂CF₂H, HCF₂CF₂OCH₂CH₂OCF₂CF₂CF₂H,
HCF₂CF₂OCH₂CH₂CH₂OCF₂CF₂CF₂H, CH₃OCH₂CH₂OCH₂CH₂F,
CH₃OCH₂CH₂OCH₂CF₃, CH₃OCH₂CH(CH₃)OCH₂CH₂F, CH₃OCH₂CH(CH₃)OCH₂CF₃,
FCH₂CH₂OCH₂CH₂OCH₂CH₂F, FCH₂CH₂OCH₂CH(CH₃)OCH₂CH₂F,
CF₃CH₂O(CH₂CH₂O)₂CH₂CF₃, CF₃CH₂OCH₂CH(CH₃)OCH₂CF₃, and any combination thereof.

11. (Currently Amended) The electrolyte according to Claim 1, further comprising a cyclic phosphonic anhydride, based on the total weight of the electrolyte, [[the]] a content of cyclic phosphonic anhydride is about 0.01-10 wt%.
12. (Currently Amended) The electrolyte according to Claim 1, further comprising one selected from [[the]] a group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluorinated chain carbonate ester, a fluorinated cyclic carbonate ester, a compound having a sulfur-oxygen double bond, and any combination thereof.
13. (Original) The electrolyte according to Claim 1, further comprising a cyclic carboxylate ester, including γ -butyrolactone or γ -valerolactone or a combination thereof.
14. (Previously Presented) An electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X and the weight percentage of the trinitrile compound is Y, where X and Y meet the conditions represented by Formula (1) and Formula (2):

$$\text{about } 2 \text{ wt\%} \leq (X+Y) \leq \text{about } 11 \text{ wt\%} \dots (1); \text{ and}$$

$$\text{about } 0.1 \leq (X/Y) \leq \text{about } 8 \dots (2).$$
15. (Currently Amended) The electrochemical device according to Claim 14, wherein the

electrode comprises a current collector and a coating on the current collector, the coating comprising a single-sided coating[[,]] and a double-sided coating ~~or a combination thereof~~, wherein:

the single-sided coating is a coating formed by applying a slurry on one surface of the current collector; and the double-sided coating is a coating formed by applying a slurry on two opposite surfaces of the current collector; and

the electrode with the single-sided coating has an electrode compaction density D1, and the electrode with the double-sided coating has an electrode compaction density D2, wherein D1 and D2 meet the relationship: about $0.8 \leq D1/D2 \leq$ about 1.2.

16. (Original) The electrochemical device according to Claim 15, wherein the electrode s comprise a cathode and a anode, wherein when the electrode is a cathode , $3.5 \text{ g/cm}^3 \leq D2 \leq 4.3 \text{ g/cm}^3$; or when the electrode is an anode , $1.2 \text{ g/cm}^3 \leq D2 \leq 1.8 \text{ g/cm}^3$.
17. (Previously Presented) An electronic device, comprising an electrochemical device that includes electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X and the weight percentage of the trinitrile compound is Y, where X and Y meet the conditions represented by Formula (1) and Formula (2):
- about $2 \text{ wt}\% \leq (X+Y) \leq$ about 11 wt% ... (1); and
- about $0.1 \leq (X/Y) \leq$ about 8 ... (2).

REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Office Action dated May 26, 2020 (USPTO Paper No. 20200423). In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

As outlined above, claims 1 and 3-17 stand for consideration in this application, wherein claims 1, 7, 12 and 15 are being amended to more particularly point out and distinctly claim the subject invention; and claim 2 is being canceled without prejudice or disclaimer. Any and all amendments to the specification and/or to the claims are fully supported throughout the disclosure of the invention. Applicant submits that no new matter is being introduced into this application through the submission of this response.

Formality Rejections

Claims 1-17 were rejected under 35 U.S.C. §112, second paragraph (pre-AIA), or 35 U.S.C. §112(b) (post-AIA) as being indefinite for language throughout the claims which the Examiner considered to be undefined or lacking in proper antecedent basis.

As outlined above, the claims are being amended to more particularly point out and distinctly claim the subject invention in accordance with the Examiner's requirements, including but not limited to providing proper antecedent basis for each element recited in the claims. However, specifically with respect to the rejection of claim 10, Applicant will point out that claim 8 from which claim 10 depends, as originally filed, recites in part "*The electrolyte according to Claim 1, further comprising a fluoroether comprising at least one of the compounds of Formula (8), Formula (9), Formula (10) or Formula (11): . . .*" [emphasis added]. In view of the recitation of claim 8, Applicant will contend that the recitation of "the fluoroether" in claim 10 does in fact have proper antecedent basis. The rejection with respect to claim 10 is thus without proper grounds. As such, Applicant will submit that all the Examiner's formality rejections have been obviated and/or rendered moot.

Prior Art Rejections

The Examiner rejected claims 1-4, 7-10, 12 and 14-17 under 35 U.S.C. §103 as being unpatentable over US Publication No. 2017/0324116 to Ohashi. In addition, the Examiner rejected claims 5-6 and 13 under 35 U.S.C. §103(a) as being unpatentable over Ohashi in view of US Publication No. 2017/0069934 to Kim et al. Further, the Examiner rejected claim 11 under 35 U.S.C. §103(a) as being unpatentable over Ohashi in view of US Publication No. 2017/0317385 to Zhang et al. Applicant has reviewed the above-noted rejections and hereby respectfully traverses.

A proper obviousness rejection requires establishing that the prior art references, when combined, teach or suggest all of the claim limitations (MPEP §2143). Furthermore, “a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR Int’l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007). Rather, a “convincing line of reasoning supporting rejection” must be presented (MPEP §2144). The rationale to support a conclusion that a claim would have been obvious is that “a person of ordinary skill in the art would have been motivated to combine the prior art to achieve the claimed invention and that there would have been a reasonable expectation of success.” *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co.*, 464 F.3d 1356, 1360 (Fed. Cir. 2006).

The present invention as recited in independent claim 1 is directed to an electrolyte, comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X and a weight percentage of the trinitrile compound is Y, **where X and Y meet conditions represented by Formula (1) and Formula (2): about 2 wt% $\leq (X+Y) \leq$ about 11 wt% ... (1); and about 0.1 $\leq (X/Y) \leq$ about 8 ... (2),** wherein, based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z, where Y and Z meet a condition represented by Formula (3): about 0.01 $\leq (Y/Z) \leq$ about 0.3 ... (3).

Further, the present invention as recited in independent claim 14 is directed to an electrochemical device, wherein the electrochemical device comprises electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile

compound is X and the weight percentage of the trinitrile compound is Y, **where X and Y meet the conditions represented by Formula (1) and Formula (2): about 2 wt% $\leq$ (X+Y) $\leq$ about 11 wt% ... (1); and about 0.1 $\leq$ (X/Y) $\leq$ about 8 ... (2).**

Even more, the present invention as recited in independent claim 17 is directed to an electronic device, comprising an electrochemical device that includes electrodes and an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X and the weight percentage of the trinitrile compound is Y, **where X and Y meet the conditions represented by Formula (1) and Formula (2): about 2 wt% $\leq$ (X+Y) $\leq$ about 11 wt% ... (1); and about 0.1 $\leq$ (X/Y) $\leq$ about 8 ... (2).**

In contrast to the claimed invention, the primary reference of Ohashi teaches that the content of the nitrile compound is preferably equal to or greater than 0.01% and less than or equal to 6% by mass (see paragraph [0072] of Ohashi). Ohashi does not teach or suggest that a weight percentage X of the dinitrile compound and a weight percentage Y of the trinitrile compound should meet: about 2 wt% $\leq$ (X+Y) $\leq$ about 11 wt%. In addition, Ohashi does not teach or suggest that a weight percentage Y of the trinitrile compound and a weight percentage Z of the propyl propionate should meet: about 0.01 $\leq$ (Y/Z) $\leq$ about 0.3. Therefore, Ohashi by itself cannot and does not disclose or suggest all the limitations of the independent claim 1 as now amended. Ohashi cannot and does not anticipate or render obvious each and every feature of the claimed invention as recited in at least the independent claim 1. Rather, the present invention as claimed is distinguishable and thereby allowable over the primary reference of Ohashi.

The secondary references of Kim et al. and Zhang et al. also do not disclose or suggest the above-mentioned features of the claimed invention. In addition, the Examiner has presented no evidence in the cited references or in any other manner that the electrolyte meeting the above conditions of the claimed invention would be commonly known to those of ordinary skill in the art. Therefore, Applicant will contend that those skilled in the art could not and would not arrive at the combination of features that embody the claimed invention, given the teachings of Ohashi, Kim et al., and Zhang et al. Thus, the combination of Ohashi in view of Kim et al., and Zhang et al. cannot and does not render obvious each and every feature of the claimed invention as recited in at least the independent claim 1. Rather, the present invention as claimed is distinguishable and thereby allowable over Ohashi in view of Kim et al., and Zhang et al.

With respect to the independent claims 14 and 17, these claims recite features the same or substantially the same as those of claim 1, along with other patentably distinct elements. Thus, Applicant will contend that the combination of Ohashi in view of Kim et al., and Zhang et al. cannot and does not render obvious each and every feature of the claimed invention as recited in at least the independent claims 14 and 17 for the same or similar reasons. Rather, the present invention as claimed is again distinguishable and thereby allowable over Ohashi in view of Kim et al., and Zhang et al.

Even more, per the standards set forth in *Graham v. John Deere Co.*, 383 U.S. 1 (1966), it is well established that unexpected results are a secondary consideration that may tip the scales towards a conclusion of nonobviousness. Such unexpected results may include (a) greater than expected results; (b) superiority of a shared property; (c) presence of an unexpected property; and (d) absence of an expected property (see MPEP §716.02(a)). In this case, Applicant will point out that, as shown by the results of Examples S2-2 and Comparison Example D2-3, and Example S2-5 and Comparison Example D2-4 in Table 2 (see specification as filed), the ratio of the contents of the trinitrile compound and dinitrile compound has a great influence on the DC internal resistance. In the structure and operation of the present invention as claimed, it was found that when Y/Z is within the range of 0.01-0.3, the electrolyte has a better inhibition effect on the increase in the DC internal resistance. Since the cited prior art fails to show or suggest every feature of the claimed invention, as shown above, the same prior art could not and would not show or suggest effects or results that were not expected or achievable by the prior art, much less those by the claimed invention. Thus, the results yielded by the claimed invention are unexpected in view of the cited prior art.

Dependent Claims

With respect to the dependent claims 2-13 and 15-16, it is well established that where an independent claim is nonobvious under 35 U.S.C. §103, then any claim depending therefrom is nonobvious. *In re Fine*, 5 U.P.S.Q.2d 1596, 1598 (Fed. Cir. 1988). Therefore, since independent claims 1, 14 and 17 are distinguishable and thereby allowable over the prior art of record, as shown above, dependent claims 2-13 and 15-16 are equally distinguishable and thereby allowable over the prior art of record.

Conclusion

In view of all the above, Applicant respectfully submits that certain clear and distinct differences as discussed exist between the present invention as now claimed and the prior art as a whole. These differences are more than sufficient that the present invention as now claimed would not have been anticipated nor rendered obvious given the prior art. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application as amended is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicant's undersigned representative at the address and phone number indicated below.

Respectfully submitted,

/juan.carlos.a.marquez/

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August 25, 2020

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 16/211,853		Filing Date 12/06/2018		☐ To be Mailed	
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
FOR		(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE (\$)		FEE (\$)			
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A	N/A	N/A					
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A	N/A	N/A					
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A	N/A	N/A					
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =	*	x \$100 =					
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =	*	x \$460 =					
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL					
APPLICATION AS AMENDED - PART II									
		(Column 1)		(Column 2)	(Column 3)				
AMENDMENT	08/25/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0	x \$100 =		0	
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0	x \$460 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE		0	
		(Column 1)		(Column 2)	(Column 3)				
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	*	Minus	**	=	x \$0 =			
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x \$0 =			
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
						TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.						LIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".						/KAREN T WASHINGTON/			
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".									
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.									

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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NOTICE OF ALLOWANCE AND FEE(S) DUE

38327 7590 09/22/2020
Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

EXAMINER

DOUYETTE, KENNETH J

ART UNIT

PAPER NUMBER

1725

DATE MAILED: 09/22/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/211,853	12/06/2018	Kefei WANG	LEEL-0091	4935

TITLE OF INVENTION: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	12/22/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

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Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

38327 7590 09/22/2020
Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/211,853	12/06/2018	Kefei WANG	LEEL-0091	4935

TITLE OF INVENTION: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	12/22/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
DOUYETTE, KENNETH J	1725	429-326000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/211,853	12/06/2018	Kefei WANG	LEEL-0091	4935
38327	7590	09/22/2020	EXAMINER	
Juan Carlos A. Marquez Marquez Intellectual Property Law Office PLLC 1629 K Street, NW Suite 300 Washington, DC 20006			DOUYETTE, KENNETH J	
			ART UNIT	PAPER NUMBER
			1725	
DATE MAILED: 09/22/2020				

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.** Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b) (2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

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1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/211,853	Applicant(s) WANG et al.	
	Examiner KENNETH J DOUYETTE	Art Unit 1725	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 8/25/2020.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1 and 3-17. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☒ All b) ☐ Some *c) ☐ None of the:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)	5. ☐ Examiner's Amendment/Comment
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.	6. ☒ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.	7. ☐ Other _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	

/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	
---	--

DETAILED ACTION

Response to Amendment

1. Claims 1 and 3-17 are pending in the application. Previous grounds of rejection have been withdrawn as a result of the amendment submitted 8/25/2020.

Allowable Subject Matter

2. Claims 1 and 3-17 are allowed.

3. The following is an examiner's statement of reasons for allowance: Applicant's arguments submitted 8/25/2020 with respect to instant independent claims 1, 14 and 17 have been found persuasive. Instant independent claim 1 discloses an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate, wherein a ratio of the three aforementioned compounds is defined as set forth in the claim. Further, claims 14 and 17 each recite an electrochemical device and electronic device, respectively, with similar ratios of aforementioned compounds as set forth in instant independent claim 1.

Ohashi, Kim, and Zhang are considered to be the prior art references of record closest to the aforementioned limitations of the instant independent claims. However, the aforementioned references, neither alone nor in combination, discloses nor render obvious the aforementioned limitations of instant independent claims 1, 14 and 17. Namely, while the references disclose an electrolyte including propyl propionate, a dinitrile, and a trinitrile compound therein, it does not disclose nor render obvious the specific combination of compounds forming the ratios of the instant independent claims.

Also, Applicants have successfully argued that the claimed ratios in the instant claims display unexpected results with respect to DC internal resistance. Namely, by pointing out differences in performance with respect to DC internal resistance between Examples S2-2, Comparison Example D2-3, and between Example S2-5 and Comparison Example D2-4 in Table 2 of the instant specification, the claimed ratios of electrolyte compounds as set forth in the claims display unexpected results with respect to DC internal resistance and as such the applied references do not disclose nor render obvious all of the limitations of the electrolyte of the instant independent claims.

A further search of the prior art did not reveal any additional references that alleviate the deficiencies of the previously applied prior art references. Therefore, instant independent claims 1, 14, and 17 have been found allowable over the cited prior art references of record.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to KENNETH J DOUYETTE whose telephone number is (571)270-1212. The examiner can normally be reached on Monday - Friday 8A - 4P EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <https://ppair-my.uspto.gov/pair/PrivatePair>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/KENNETH J DOUYETTE/
Primary Examiner, Art Unit 1725

Issue Classification 	Application/Control No. 16/211,853	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner KENNETH J DOUYETTE	Art Unit 1725

CPC						
Symbol					Type	Version
H01M	/	10	/	0566	F	2013-01-01
H01M	/	10	/	0525	I	2013-01-01
H01M	/	2300	/	0025	A	2013-01-01

CPC Combination Sets						
Symbol			Type	Set	Ranking	Version
	/		/			

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	16	
/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	14 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

U.S. Patent and Trademark Office

Part of Paper No.: 20200831

Issue Classification 	Application/Control No. 16/211,853	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner KENNETH J DOUYETTE	Art Unit 1725

INTERNATIONAL CLASSIFICATION			
CLAIMED			
H01M	/	10	/ 0566
H01M	/	10	/ 0525
H01M	/	4	/ 13
NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
429	188

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	16	
/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	14 September 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

U.S. Patent and Trademark Office

Part of Paper No.: 20200831

Issue Classification 	Application/Control No. 16/211,853	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner KENNETH J DOUYETTE	Art Unit 1725

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	9	10												
	2	10	11												
2	3	11	12												
3	4	12	13												
4	5	13	14												
5	6	14	15												
6	7	15	16												
7	8	16	17												
8	9														

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 16	
/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725 (Primary Examiner) _____ (Date) _____		14 September 2020 (Date)	O.G. Print Claim(s) 1 O.G. Print Figure 4

Search Notes 	Application/Control No. 16/211,853	Applicant(s)/Patent Under Reexamination WANG et al.
	Examiner KENNETH J DOUYETTE	Art Unit 1725

CPC - Searched*		
Symbol	Date	Examiner
H01M 10/05, 10/0566, 10/0545	05/20/2020	KD
updated above CPC search	09/14/2020	KD

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
PALM inventor database search	05/20/2020	KD
EAST text search, see search history	05/20/2020	KD
updated above PALM and EAST text search, see search history	09/14/2020	KD

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
H01M	10/05, 10/0566, 10/0545	09/14/2020	KD

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	h01m\$.cpc. and battery and propyl adj propionate same dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:47
L2	2	battery and propyl adj propionate same dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:47
L3	10	h01m\$.cpc. and battery and propyl adj propionate and dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:47
L4	0	("2016/0294007").URPN.	USPAT	OR	OFF	2020/08/31 12:49
L5	3	("20120009487" "20140072865" "20140134461").PN. OR ("9812739").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/08/31 12:49
L6	0	("2017/0324116").URPN.	USPAT	OR	OFF	2020/08/31 12:49
L7	7	h01m\$.cpc. and battery and propyl adj propionate and dinitrile same \$trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:50
L8	7	h01m\$.cpc. and battery and propyl adj propionate and dinitrile and \$trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:51
L9	12	h01m\$.cpc. and battery and propyl adj propionate same dinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:51
L10	2	h01m\$.cpc. and battery and propyl adj propionate near2 (ratio amount)	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:52
L11	26	h01m\$.cpc. and battery and propyl adj propionate near10 (ratio amount)	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:53
L12	6	h01m\$.cpc. and battery and propyl adj propionate near10 (ratio amount) and dinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:53
L13	6	h01m\$.cpc. and battery and propyl adj propionate near10 (ratio amount) and \$10dinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:56
L14	20	h01m\$.cpc. and battery and propyl adj propionate same (ratio amount) and \$10dinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:56

L15	3	("20100304225" "20120171581" "6455200").PN. OR ("10211484").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/08/31 12:57
L16	20	("3442629" "5270134" "5506068" "5580683" "5601949" "5716737" "5783328" "5830600" "5866093" "5922494" "5928812").PN. OR ("6455200").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/08/31 12:58
L17	20	battery and propyl adj propionate same (ratio amount) and \$10dinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:58
L18	10	battery and propyl adj propionate and dinitrile same trinitrile	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:58
L19	2	battery and propyl adj propionate and dinitrile same trinitrile	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 12:58
L20	2	battery and propyl adj propionate and dinitrile and trinitrile	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 12:58
L21	85	h01m\$.cpc. and battery and propyl adj propionate same (nitrile dinitrile trinitrile)	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:59
L22	8	h01m\$.cpc. and battery and propyl adj propionate same ratio same (nitrile dinitrile trinitrile)	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 12:59
L23	8	battery and propyl adj propionate same ratio same (nitrile dinitrile trinitrile)	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 13:00
L24	1	h01m\$.cpc. and battery and propyl adj propionate near3 (nitrile dinitrile trinitrile)	US-PGPUB; USPAT; USOCR	OR	ON	2020/08/31 13:00
L25	18	h01m\$.cpc. and battery and propyl adj propionate same (nitrile dinitrile trinitrile)	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 13:00
L26	63	battery and propyl adj propionate same (nitrile dinitrile trinitrile)	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 13:01
L27	19	battery and (ratio amount) same propyl adj propionate same (nitrile dinitrile trinitrile)	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 13:01
L28	0	battery and (ratio amount) near4 propyl adj propionate same (nitrile dinitrile trinitrile)	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 13:02
L29	5	battery and propyl adj propionate near10 (nitrile dinitrile trinitrile)	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 13:02

L30	23	battery and propyl adj propionate same (nitrile dinitrile trinitrile) and (dinitrile trinitrile)	FPRS; EPO; JPO; DERWENT	OR	ON	2020/08/31 13:02
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EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L31	0	(battery and propyl adj propionate same (nitrile dinitrile trinitrile) and (dinitrile trinitrile)).clm.	USPAT	OR	ON	2020/08/31 13:03
L32	0	(battery and propyl adj propionate same (nitrile dinitrile trinitrile)).dm.	USPAT	OR	ON	2020/08/31 13:03
L33	0	(battery and propyl adj propionate and (nitrile dinitrile trinitrile)).dm.	USPAT	OR	ON	2020/08/31 13:03
L34	48	(battery and propyl adj propionate).clm.	USPAT	OR	ON	2020/08/31 13:03
L35	0	(battery and propyl adj propionate same ratio).clm.	USPAT	OR	ON	2020/08/31 13:03
L36	0	(battery and propyl adj propionate same nitrogen).clm.	USPAT	OR	ON	2020/08/31 13:03
L37	3	(battery and propyl adj propionate and nitrogen).clm.	USPAT	OR	ON	2020/08/31 13:03
L38	38	(battery and propyl adj propionate same group).clm.	USPAT	OR	ON	2020/08/31 13:04
L39	0	(battery and propyl adj propionate same carbon).clm.	USPAT	OR	ON	2020/08/31 13:04
L40	0	(battery and propyl adj propionate same additive).clm.	USPAT	OR	ON	2020/08/31 13:04

8/31/2020 1:05:14 PM

C:\Users\kdouyette1\Documents\EAST\Workspaces\blank starts.wsp

To: USPTO@dockettrak.com,mail@marqueziplaw.com,lniu@marqueziplaw.com
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 38327

Sep 22, 2020 04:00:46 AM

Dear PAIR Customer:

Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 38327 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:

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Application	Document	Mailroom Date	Attorney Docket No.
16211853	NOA	09/22/2020	LEEL-0091

To view your correspondence online or update your email addresses, please visit us anytime at <https://sportal.uspto.gov/secure/myportal/privatepair>.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

38327 7590 09/22/2020
Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/211,853	12/06/2018	Kefei WANG	LEEL-0091	4935

TITLE OF INVENTION: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	12/22/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
DOUYETTE, KENNETH J	1725	429-326000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Juan Carlos A. Marquez2 Marquez IP Law Office, PLLC

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

NINGDE AMPEREX TECHNOLOGY LIMITED

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

NINGDE CITY, FUJIAN PROVINCE, CHINA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 60-0155

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /juan.carlos.a.marquez/Date October 1, 2020Typed or printed name Juan Carlos A. MarquezRegistration No. 34,072

Electronic Patent Application Fee Transmittal				
Application Number:		16211853		
Filing Date:		06-Dec-2018		
Title of Invention:		ELECTROLYTE AND ELECTROCHEMICAL DEVICE		
First Named Inventor/Applicant Name:		Kefei WANG		
Filer:		Juan Carlos A. Marquez/Lily Niu		
Attorney Docket Number:		LEEL-0091		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt	
EFS ID:	40732498
Application Number:	16211853
International Application Number:	
Confirmation Number:	4935
Title of Invention:	ELECTROLYTE AND ELECTROCHEMICAL DEVICE
First Named Inventor/Applicant Name:	Kefei WANG
Customer Number:	38327
Filer:	Juan Carlos A. Marquez/Lily Niu
Filer Authorized By:	Juan Carlos A. Marquez
Attorney Docket Number:	LEEL-0091
Receipt Date:	01-OCT-2020
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Time Stamp:	11:48:03
Application Type:	Utility under 35 USC 111(a)

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16211853
	Filing Date	2018-12-06
	First Named Inventor	Kefei WANG
	Art Unit	
	Examiner Name	
	Attorney Docket Number	LEEL-0091

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/K.J.D/	1	9812739		2017-11-07	Kefei WANG NINGDE AMPEREX TECHNOLOGY LIMITED		
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/K.J.D/	1	105074993	CN	A	2015-11-18	SK Innovation Co., Ltd.	English Abstract	×	
/K.J.D/	2	101640290	CN	A	2010-02-03	Sanyo Electric Co.	English Abstract	☒	
/K.J.D/	3	103928708	CN	A	2014-07-16	Samsung SDI Co., Ltd.	English Abstract	☒	



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/211,853	11/10/2020	10833363	LEEL-0091	4935

38327 7590 10/21/2020

Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
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ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 110 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

NINGDE AMPEREX TECHNOLOGY LIMITED, Ningde City, CHINA;
Kefei WANG, Ningde City, CHINA;
Qiao ZENG, Ningde City, CHINA;
Liangzhen XIAO, Ningde City, CHINA;
Fei WU, Ningde City, CHINA;

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IR 103 (Rev. 10/09)

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Oct 22, 2020 04:01:26 AM

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Application	Document	Mailroom Date	Attorney Docket No.
16211853	ISSUE.NTF	10/21/2020	LEEL-0091

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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.);

DOCKET NO. 2:22-cv-232	DATE FILED 6/24/2022	U.S. DISTRICT COURT Eastern District of Texas
PLAINTIFF Ningde Amperex Technology Limited		DEFENDANT Zhuhai CosMX Battery Co., Ltd.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,971,706	4/6/2021	Ningde Amperex Technology Limited
2 11,329,352	5/10/2022	Ningde Amperex Technology Limited
3		
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED 8/4/2022	INCLUDED BY ☒ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,833,363	11/10/2020	Ningde Amperex Technology Limited
2 10,964,987	3/30/2021	Ningde Amperex Technology Limited
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT		
CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
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