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# Datasheet for the decision of 21 March 2017

**Case Number:** T 2285/13 - 3.3.05

**Application Number:** 07700944.7

**Publication Number:** 1987559

**IPC:** H01M10/40

**Language of the proceedings:** EN

**Title of invention:**
NON-AQUEOUS ELECTROLYTE AND ELECTROCHEMICAL DEVICE WITH AN IMPROVED SAFETY

**Applicant:**
LG Chem, Ltd.

**Headword:**
Flame retardance/LG

**Relevant legal provisions:**
EPC 1973 Art. 54(1), 54(2), 56
EPC Art. 123(2), 52(1), 54(3)
RPBA Art. 13(1), 13(3)

**Keyword:**
Amendments - allowable (yes)
Novelty - (yes)
Inventive step - (yes)

**Decisions cited:**

**Catchword:**

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**Beschwerdekammern**
**Boards of Appeal**
**Chambres de recours**

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

**Case Number: T 2285/13 - 3.3.05**

# D E C I S I O N
# of Technical Board of Appeal 3.3.05
# of 21 March 2017

| | |
|---|---|
| **Appellant:** (Applicant) | LG Chem, Ltd.<br>LG Twin Tower<br>20, Yoido-dong<br>Youngdungpo-ku<br>Seoul 150-721 (KR) |
| **Representative:** | Hoffmann Eitle<br>Patent- und Rechtsanwälte PartmbB<br>Arabellastraße 30<br>81925 München (DE) |
| **Decision under appeal:** | **Decision of the Examining Division of the European Patent Office posted on 17 June 2013 refusing European patent application No. 07700944.7 pursuant to Article 97(2) EPC.** |

**Composition of the Board:**

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| **Chairman** | E. Bendl |
| **Members:** | A. Haderlein |
| | P. Guntz |

## Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the examining division to refuse European patent application No. 07 700 944.7.

II. The examining division held that the subject-matter of claim 1 of the then pending request was new in view of any one of the documents cited in the supplementary European search report including the following:

D1: WO 2007/094625 A1
D2: WO 2007/094626 A1
D3: EP 1 508 934 A1
D4: EP 1 696 501 A1
D5: US 6 743 947 B1
D11: WO 98/15024 A1
D12: WO 2005/069423 A1

but did not meet the requirements of inventive step (Article 52(1) EPC in conjunction with Article 56 EPC 1973) when starting from D3 as the closest prior art and in view of

D10: Xu, K. et al., Evaluation of Fluorinated Alkyl Phosphates as Flame Retardants in Electrolytes for Li-Ion Batteries, J. Electrochem. Soc., 150(2), A170-175 (2003).

In the first-instance proceedings, the examining division held that documents D1 to D5 disclosed subject-matter which "overlapped" with that of the present application (see European search opinion dated 26 April 2010), leading to lack of novelty at least

with respect to D3 to D5.

III. At the oral proceedings before the board, the appellant filed a single request replacing all previously filed requests.

IV. Claim 1 of this request reads as follows:

"1. A non-aqueous electrolyte comprising a lithium salt and a solvent, the electrolyte containing, based on the weight of the electrolyte, more than 10 and up to 40 wt% of fluoroethylene carbonate and 1-10 wt% of an aliphatic di-nitrile compound represented by Formula 3:

N≡C-R-C≡N [Formula 3]

wherein R is $-(CH_2)_n-$, and n is an integer of 2-12."

Claims 2 and 3 are directed to specific embodiments of the electrolyte according to claim 1, whereas claim 4 is directed to an electrochemical device comprising *inter alia* an electrolyte as defined in any of the preceding claims.

V. The arguments of the appellant may be summarised as follows:

Claim 1 complied with Article 123(2) EPC. The subject-matter of claim 1 differed from the electrolyte disclosed in D12 by the presence of fluoroethylene (FEC) in an amount of more than 10 and up to 40 wt%. Several advantages were associated with these distinguishing features. Firstly, improved inhibition of gas generation at elevated temperatures was achieved, due to the synergistic effects between the

aliphatic nitrile compound and FEC as suggested in the passage on page 8, lines 8 to 15 of the description as originally filed. Secondly, another improvement was improved prevention of battery ignition or explosion. Thirdly, using FEC led to improved flame retardance, as indicated several times in the description. This latter effect was also plausible in view of commonly known halogen flame retardants. D3 taught away from using FEC in an amount of more than 10 wt%.

VI. Request

The appellant requested that the impugned decision be set aside and that a patent be granted on the basis of the sole request filed at the oral proceedings before the board.

## Reasons for the Decision

1. Admissibility of the sole claim request

The submission of the amended set of claims is considered to be the direct result of the objections raised by the board in its communication and of the discussion which took place in the course of the oral proceedings. Therefore, the board does not see any reason not to admit the sole request (Article 13(1) and (3) RPBA).

2. Amendments

2.1 Claim 1 is based on claims 1 to 3 as originally filed (i.e. claims 1 to 3 of the international publication of the A1 pamphlet) and on the passage on page 3, lines 9 et seq. of the application as filed. Reference is also made to the examples according to the invention using

FEC as representative of Formula 1 referred to in originally filed claim 1. Moreover, in the passage on page 10, lines 2 to 8, a direct and unambiguous disclosure for the feature "more than 10 wt%" can be found.

2.2 Claims 2 to 4 are based on originally filed claims 6 to 8.

2.3 The requirement set forth in Article 123(2) EPC is therefore met.

3. Novelty

In the first-instance proceedings, the examining division held the view that documents D1 to D5 disclosed subject-matter which "overlapped" with the subject-matter of the application, leading to a novelty objection at least with respect to documents D3 to D5.

3.1 D1 and D2 have a priority date (15 February 2006) which post-dates that of the present application (12 January 2006). The board notes that the examining division did not call into question the validity of the claimed priority. The board also sees no reason to do so since the published international application appears to be a translation of the priority document. In particular, the priority document contains 26 claims, as in the published application, and the figures of the A1 pamphlet correspond to those contained in the priority document. Thus, neither D1 nor D2 constitutes prior art under Article 54(1) and (2) EPC 1973. Nor do they form part of the prior art according to Article 54(3) EPC.

3.2 D3 relates to electrolytes containing mono-nitriles (see paragraph [0015]), and discloses neither di-nitriles nor FEC in an amount of more than 10 wt% (cf. paragraphs [0023] and [0024]).

3.3 D4, which claims an earlier priority date but was filed after the priority date of the application in suit, discloses FEC (paragraph [0035]) and aliphatic di-nitrile compounds (paragraph [0021], formula 4). D4 is however silent about the concentration of FEC.

3.4 D5 mentions FEC (see claim 4), but does not disclose concentrations for that compound.

3.5 With regard to the remaining documents cited in the course of the examination proceedings the board does not see any reason to differ from the examining division's view that the claimed combination of FEC with di-nitriles is not disclosed therein.

3.6 It follows that the subject-matter of claim 1 and consequently also of claims 2 to 4 is new.

4. Inventive step

4.1 Invention

The invention concerns a non-aqueous electrolyte.

4.2 Closest prior art

4.2.1 The closest prior art is normally a document conceived for the same purpose or aiming at the same objective as the claimed invention and having the most relevant structural features in common. Generally, the closest prior art should deal with the same or a similar

technical problem as the claimed invention.

4.2.2 The purpose of the application is to provide a non-aqueous electrolyte suitable for improving battery safety, and in particular suitable for preventing ignition or explosion of the battery (see page 1, line 34 to page 2, line 1; page 3, lines 9 et seq.; page 6, lines 10 et seq.; page 7, lines 7 et seq.).

4.2.3 In the decision under appeal the examining division started from D3 as the closest prior art. D3 concerns a non-aqueous electrolyte capable of inhibiting high-temperature swelling (paragraph [0009]). D3 does not deal with ignition or explosion. Moreover, D3 discloses the use of mono-nitriles (see paragraph [0015]), which were covered by claim 1 of the request underlying the impugned decision. In contrast, claim 1 of the now pending request is limited to di-nitriles. D3 discloses the use of FEC (see paragraph [0023]), but is silent as regards di-nitriles. D3 also does not disclose the FEC in an amount of more than 10 wt% (cf. paragraph [0024] of D3).

4.2.4 D12 addresses the issue of the safety of the battery and in particular fire and explosion phenomena (page 3, lines 11 et seq.). It discloses embodiments which are said not to catch fire at prolonged exposure at elevated temperatures (see examples 1, 2, 8 and 9; page 23 "Hot box text"; Table 2 on page 24). D12 discloses electrolytes containing succinonitrile (an aliphatic di-nitrile compound according to Formula 3 of claim 1 at issue) in an amount falling within the boundaries of the range called for in claim 1 (see for instance example 1).

4.2.5 While it could be argued that the disclosures of D3 and D12 both have the same number of features in common with the claimed subject-matter, D12 is directed to the same or at least a similar purpose as the application.

4.2.6 For these reasons, the closest prior art is D12.

4.3 Problem

According to the application as filed, the problem to be solved was to improve prevention of battery ignition caused by external physical shock such as thermal shock, and/or to prevent ignition or explosion caused by internal short circuit (page 3, lines 14 et seq.). According to the appellant, the problem to be solved was also to improve inhibition of gas generation. Also, according to the appellant, the use of large amounts of FEC, as called for in claim 1, led to significant flame retardance.

4.4 Solution

The application proposes to solve this problem by a non-aqueous electrolyte according to claim 1 characterised by containing more than 10 and up to 40 wt% of FEC.

4.5 Success of the solution

4.5.1 Figure 1 of the application shows that exposing a battery comprising an electrolyte according to claim 1 to 150°C for more than 10 hours did not result in its ignition or explosion. The batteries according to the examples of D12 however also did not catch fire after exposure to 160°C for 1 hour (see page 23, line 29 et seq.: "Hot box test"; Table 2 on page 24). In view

of these data and due to the lack of evidence comparing both types of electrolytes using identical conditions and parameters, the board has doubts as to whether any improvement in terms of preventing ignition or explosion can be acknowledged.

4.5.2 According to the application, page 8, lines 8 et seq., the electrolyte according to claim 1 results in improved inhibition of gas generation.

D12 however already addresses this issue and teaches that the use of an excessive amount of vinylene carbonate (VC) results in gas generation at high temperatures (page 14, line 29 to page 15, line 2)). Therefore, the amount of VC is said to be less than 5 wt% in order to avoid the problem of gas generation (*loc.cit.*). As the examples of D12 only use 1 wt% VC it is not credible that a significant amount of gas is generated and, therefore, it is not credible, or at least has not been shown, that the electrolyte according to claim 1 leads to an improvement in this respect.

4.5.3 With respect to flame retardance, the application makes reference to an improvement at several points, see for example page 3, line 2 and page 6, lines 10 et seq. In particular, the latter passage refers to flame retardance with respect to ethylene carbonate (EC) because of the presence of fluorine in FEC. The board notes that in examples 1, 2, 8 and 9 of D12, which are said not to have caught fire (see Table 2 on page 24), 1% VC along with halogen-free solvents (EC, propylene carbonate and diethyl carbonate) is used. Considering, as submitted by the appellant, that commonly known flame retardants make use of the flame-retarding effect of halogens, it is plausible that the composition

according to claim 1, using more than 10 wt% and up to 40 wt% FEC leads to increased flame retardance (cf. also D10, abstract, penultimate sentence). Moreover, while claim 1 does not exclude the presence of VC, it is credible that the addition of more than 10 wt% FEC to the compositions disclosed in D12 which comprise 1 wt% VC led to improved flame retardance because it is plausible that the presence of fluorine in FEC will also lead to delayed flammability of the VC, for instance at temperatures exceeding those used in D12 and/or at prolonged exposure times or if the battery is subjected to physical stress which may ultimately cause it to leak.

The board also notes that in examples 1 and 2 on page 13 of the application FEC is used in amounts of 20 and 30 wt% respectively, which are well within the range covered by claim 1. Although neither the application nor any evidence on file contains experimental data that would demonstrate improved flame retardance vis-a-vis D12, in view of the above considerations the board finds it credible that this is indeed achieved.

4.6 Reformulation of the technical problem

The problem is therefore reformulated, and consists in providing a non-aqueous electrolyte showing improved flame retardance.

4.7 Obviousness

4.7.1 D3 does not address the problem of flame retardance. Moreover, it teaches that more than 10 wt% of a carbonate-based additive such as FEC would have a detrimental effect on high-temperature cycle life

characteristics and cause swelling to occur (paragraphs [0023] and [0024]). In view of this, D3 in combination with the teaching of the closest prior art D12 does not render the proposed solution obvious.

4.7.2 D10 (see title) addresses flame retardance in lithium ion batteries but suggests solving this problem by using fluoroalkyl phosphates. D10 does not mention FEC for this purpose, let alone in an amount exceeding 10 wt%. Thus, although this document gives a hint towards the use of halogenated solvents to improve flame retardance, the solution proposed in D10 is different from the one claimed.

4.7.3 D11 discloses tri-solvent systems for use in alkali metal-ion batteries using between 10 and 100 vol% FEC (page 8, lines 18 et seq.; example 14 and table 14 on page 27; Figure 7), but is silent about battery safety and in particular does not address flame retardance.

4.7.4 None of the other documents cited in the course of the proceedings before the examining division teaches improving flame retardance by using FEC in an amount within the range specified in claim 1.

4.7.5 Therefore, the subject-matter of claim 1 is not obvious having regard to the cited prior art.

This reasoning applies *mutatis mutandis* to claims 2 to 4.

4.8 Thus, the requirement set forth in Article 56 EPC is met.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the claims of the new sole request as submitted during the oral proceedings of 21 March 2017, and a description to be adapted.

The Registrar: The Chairman:

C. Vodz E. Bendl

Decision electronically authenticated