Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 24 March 2023

Case Number: T 2876/18 - 3.3.10

Application Number: 15186267.9

Publication Number: 3000863

IPC: C09K11/02, C09K11/62, C09K11/66, C09K11/88, H01L33/50, G09G3/36

Language of the proceedings: EN

Title of invention:
LIGHT EMITTING DEVICE

Applicant:
Nichia Corporation

Headword:

Relevant legal provisions:

Keyword:

Decisions cited:

This datasheet is not part of the Decisior
It can be changed at any time and without notic

Catchword:

This datasheet is not part of the Decisior
It can be changed at any time and without notic

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 2876/18 - 3.3.10

D E C I S I O N
of Technical Board of Appeal 3.3.10
of 24 March 2023

Appellant: (Applicant)	Nichia Corporation 491-100, Oka Kaminaka-cho Anan-shi Tokushima 774-8601 (JP)
Representative:	Vossius & Partner Patentanwälte Rechtsanwälte mbB Siebertstrasse 3 81675 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 5 July 2018 refusing European patent application No. 15186267.9 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair	P. Gryczka
Members:	R. Pérez Carlón
	F. Blumer

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the examining division's decision refusing European patent application No. 15186267.9.

II. The following documents were cited:

D1 US 2010/0142189 A1
D3 WO 2007/002234 A1

III. The appellant's sole request was filed as auxiliary request 3 with the statement setting out the grounds of appeal dated 15 November 2018. Independent claims 1 and 5 read as follows:

"A light emitting device, comprising:
a light emitting element adapted to emit blue light;
a plurality of quantum dots adapted to absorb a portion of the blue light emitted from the light emitting element to emit green light; and
at least one of a KSF phosphor and a MGF phosphor,
wherein the KSF phosphor is a compound having the chemical formula:

$A_2[M_{1-a}Mn^{4+}{}_aF_6]$ (1)

where A is at least one selected from the group consisting of K^+, Li^+, Na^+, Rb^+, Cs^+, *and* NH^{4+} *(sic),*
M is at least one element selected from the group consisting of Group 4 elements and Group 14 elements, and
$0<a<0.2$; *and*
the KSF phosphor is adapted to absorb at least a portion of the blue light emitted from the light emitting element to emit red light; and

wherein the MGF phosphor is a compound having the chemical formula:

$(x-a)MgO\cdot(a/2)Sc_2O_3\cdot yMgF_2.cCaF_2\cdot(1-b)GeO_2\cdot(b/2)Mt_2O_3:zMn4^+(2)$

where $2.0\leq x\leq 4.0$,

$0<y<1.5$,

$0<z<0.05$,

$0\leq a<0.5$,

$0<b<0.5$,

$0\leq c<1.5$,

$y+c<1.5$, and

Mt is at least one element selected from Al, Ga and In; and

the MGF phosphor is adapted to absorb at least a portion of the blue light emitted from the light emitting element to emit red light;

wherein the light emitting element device further comprises:

a sealing resin covering the light emitting element; and

a quantum dot layer disposed outside the sealing resin, the quantum dot layer including a light-transmissive material and the quantum dots; and

wherein the quantum dot layer is spaced apart from the sealing resin, wherein the sealing resin includes the at least one KSF phosphor and MGF phosphor.

5. A liquid crystal display device, comprising:
a light emitting element device, wherein the light emitting device comprises:

a light emitting element adapted to emit blue light, the light emitting element disposed on a surface of a light emitting element package;

a sealing resin covering the light emitting element, the sealing resin including at least one of a KSF phosphor and a MGF phosphor,

wherein the KSF phosphor and a MGF phosphor are adapted to absorb at least a portion of the blue light emitted from the light emitting element to emit red light; and

a plurality of quantum dots adapted to absorb a portion of the blue light emitted from the light emitting element to emit green light;

a light guide plate having an upper and lower surface, the light guide plate disposed between the sealing resin and the light emitting element package;

a reflective plate disposed facing the lower surface of the light guide plate;

a quantum dot layer disposed facing the upper surface of the light guide plate, the quantum dot layer including the plurality of quantum dots;

a lower polarizing film disposed on the quantum dot layer;

a liquid crystal cell disposed on the lower polarizing film;

a color filter array disposed on the liquid crystal cell; and

an upper polarizing film disposed on the color filter array."

IV. The examining division considered document D1 to be the closest prior art. D1 disclosed a light emitting device containing a light emitting element which could emit blue light. The device also contained red and green pigments. The red pigments were of the KSF type.

The claimed light emitting device differed from that of D1 in that it had quantum dots instead of green phosphors, and in that it had said quantum dots in a layer spaced apart from the sealing resin. The distinguishing features did not interact, so each of them could be examined separately. Nanosized phosphors

were known to provide better colour purity, and the location of the green quantum dots was a straightforward design. The claimed solution was thus not inventive.

V. In point 2. of a letter dated 20 December 2019, the appellant submitted experimental evidence which showed that the relative disposition of the red phosphor (in the sealing resin) and the green quantum dots (in a layer spaced apart from the sealing resin) had an effect in terms of the device's stability.

VI. Oral proceedings before the board of appeal took place on 24 March 2023. At the end of the oral proceedings, the decision was announced.

Reasons for the Decision

1. The appeal is admissible.

2. Amendments

The basis for claim 1 is the combination of claims 1, 2 and 3 as originally filed with the passage in paragraph [0041] of the description disclosing the quantum dot layer as being spaced apart from the sealing resin. Dependent claims 2 to 4 have a basis in claims 4 to 6 as originally filed. Claims 5 to 7 correspond to original claims 8 to 10 and have not been amended.

The requirements of Article 123(2) EPC are thus fulfilled.

3. Inventive step

Claim 1 relates to a light emitting device which

contains a blue light emitting element, red phosphors and green quantum dots. The red phosphors are included in the sealing resin which covers the light emitting element. The green quantum dots are within a layer spaced apart from the sealing resin.

Claim 5 relates to a liquid crystal display having a light emitting device with a blue light emitting element, red phosphors in the sealing resin and green quantum dots in a different layer. The sealing resin and the quantum dot layer are spaced apart at least by a light guide plate.

3.1 Closest prior art

The appellant did not dispute the examining division's conclusion that document D1 was the closest prior art. The board sees no reason to disagree.

The device disclosed in D1 has a blue light emitting element and red and green phosphors within the sealing resin.

It was undisputed that the light emitting device of claim 1 and that of D1 differ on account of the following:

- The device of D1 includes green phosphors instead of green quantum dots.

- In the device of D1, red and green phosphors are located in the sealing resin; claim 1 requires the red phosphor to be in the sealing resin and the green quantum dots to be in another layer, spaced apart from the sealing resin.

3.2 Technical problem underlying the invention

The problem addressed by the claimed invention is considered to be providing a light emitting device and a liquid crystal display having good stability.

3.3 Solution

The solution to this technical problem is the light emitting device of claim 1 and the liquid crystal display of claim 5 having red phosphors in the sealing resin, which are characterised in that they require quantum dots emitting green light and in that said green quantum dots are placed in a layer spaced apart from the sealing resin.

3.4 Success

The appellant relied on the results submitted in point 2. of its letter dated 20 December 2019 to show that the problem formulated above had been credibly solved by the claimed device and display.

The experimental evidence filed compares the stability of different light emitting devices.

All the devices tested had a light emitting element, a sealing resin, a further resin as a spacer, and an outer sheet. The devices further contained green quantum dots and red KSF phosphors. Quantum dots and phosphors were placed in either the sealing resin or the outer layer, in four different relative configurations:

- both in the sealing resin, like in D1
- both in the outer sheet

- quantum dots in the sealing resin and the phosphors in the outer layer, like in D3, and
- phosphors in the sealing resin and quantum dots in the outer layer, as required by claim 1

The data obtained show (see diagrams on page 5 of the appellant's letter) that if the red phosphor is in the sealing resin and the green quantum dots are in the outer layer, as required by claim 1, the system discoloured less than in the other configurations.

In view of these results, the problem of providing a light emitting device and liquid crystal display with good stability is thus considered to be successfully solved by the use of quantum dots and by the location of the green quantum dots and the red phosphors required by claims 1 and 5.

3.5 It remains to be decided whether the proposed solution to the objective problem specified above would have been obvious to a skilled person in view of the prior art.

There is no teaching in the prior art that quantum dots should be located spaced apart from the sealing resin, let alone in order to obtain good stability.

Document D3 in fact discloses the opposite disposition. The (red) quantum dots (104) of the light emitting device (108) of Figure 1 are within the sealing resin and the green phosphors (106) are located in a separate, spaced-apart layer. In the device of D3, the quantum dots are thus placed in the vicinity of the light emitting element (102).

The claimed solution requires the quantum dots to be

placed spaced apart from the sealing resin, so that they are not heated by the light emitting element. Reducing the exposure of quantum dots to heat reduces the degradation of the device.

There is nothing in the prior art pointing towards this solution, which is thus inventive, as required by Article 56 EPC.

3.6 The examining division argued that it was obvious that the quantum dots would be heated less if placed in a layer spaced apart from the sealing resin (page 9, lines 2 to 5 of the decision under appeal).

However, the prior art does not disclose that the quantum dots are heat-sensitive. Without this knowledge, the skilled person could have placed the quantum dots spaced apart from the sealing resin, but there is no reason why they would necessarily have done so.

3.7 The appellant also relied on a number of other effects in the context of inventive step. Since the claimed solution is inventive for the reasons given above, it is not necessary to examine whether these advantages have also been achieved or whether they were taught by the prior art.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent with claims 1 to 7, filed as

auxiliary request 3 with the statement setting out the grounds of appeal dated 15 November 2018, and a description yet to be adapted.

The Registrar: The Chair:

C. Rodríguez Rodríguez P. Gryczka

Decision electronically authenticated