PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/035074	30.05.2018	30.05.2017

International Patent Classification (IPC) or both national classification and IPC
INV. H01L27/32 G02F1/1335

Applicant
SABIC GLOBAL TECHNOLOGIES B.V.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Fax: +31 70 340 - 3016	see form PCT/ISA/210	Welter, Steve Telephone No. +31 70 340-0

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-20
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-20
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-20
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following document:

D1 US 2012/248479 A1 (ANC MARIA J [US]) 4 October 2012 (2012-10-04)

1 Document D1 is regarded as being the prior art closest to the subject-matter of claim 1, and discloses in Figure 1 a multi-layer film comprising:
a first quantum dot layer 110 comprising a first polymer matrix 112 and a plurality of first quantum dots 111 disposed in the first polymer matrix, wherein the plurality of first quantum dots emit a first secondary light upon excitation by light produced from a light source; and
a second quantum dot layer 120 disposed adjacent the first quantum dot layer, the second quantum dot layer comprising a second polymer matrix 122 and a plurality of second quantum dots 121 disposed in the second polymer matrix and the plurality of second quantum dots emit a second secondary light upon excitation by light produced from the light source;
wherein
a peak wavelength of the first secondary light (630 nm, §0018) is higher than a peak wavelength of the second secondary light (560nm, §0022) and the first quantum dot layer is placed in closer adjacency to the light source 101 than the second quantum dot layer (Figure 1, §0017).

2 The subject-matter of claim 1 therefore differs at least from this known LED lighting device in that

i) at least a portion of the plurality of second quantum dots align with the gaps defined in the first polymer matrix along an axis that is orthogonal to the first quantum dot layer and the second quantum dot layer,

ii) the plurality of second quantum dots do not substantially overlap the plurality of first quantum dots along an axis orthogonal to the first quantum dot layer and the second quantum dot layer,
iii) the plurality of first quantum dots are spaced at a minimum of one radius of a first quantum dot and the plurality of second quantum dots are spaced at a minimum of one radius of a second quantum dot, and
and is therefore new (Article 33(2) PCT).

3 The problem to be solved by the features i) and ii) may be regarded as avoiding light of a short wavelength emitted from a small quantum dot to be reabsorbed by a larger quantum and converted to a longer wavelength.

4 The solution to these problems proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons: Document D1 does not mention any problem related to reabsorption of light emitted by a first quantum dot, and can thus not lead the skilled person to a solution of the objective technical problem. In D2 it is mentioned that stacks of layers with colour converting materials can be arranged in such a way that several areas are created that do not overlap, see Figure 5. However, D2 does not disclose to use quantum dots but rather very specific organic molecules that act as dual-emitter, nor does D2 propose to define gaps in the layers comprising the color changing material. The skilled person does therefore also get no indication from D2 how to solve the objective technical problem. The subject-matter of claim 1 does therefore involve an inventive step (Article 33(3) PCT).

5 The multi-layer films of independent claims 19 and 20 also comprise features i) and iii) and therefore also considered to be new and inventive.

Claims 2-18 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

6 All claims 1-20 fulfil the requirements of industrial applicability (Article 33(4) PCT).