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**Datasheet for the decision  
of 24 May 2011**

**Case Number:** T 1604/09 - 3.2.08

**Application Number:** 04255157.2

**Publication Number:** 1516944

**IPC:** C30B 7/00

**Language of the proceedings:** EN

**Title of invention:**

The improvement of the luminescent efficiency of Semiconductor Nanocrystals by Surface Treatment

**Applicant:**

Samsung Electronics Co., Ltd

**Headword:**

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**Relevant legal provisions:**

EPC Art. 54, 56

**Relevant legal provisions (EPC 1973):**

-

**Keyword:**

"Novelty (yes) - after amendments"

"Inventive step (yes) - after amendments"

**Decisions cited:**

-

**Catchword:**

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Case Number: T 1604/09 - 3.2.08

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.08  
of 24 May 2011

**Appellant:** Samsung Electronics Co., Ltd.  
416, Maetan-Dong  
Yeongtong-Gu  
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Gyeonggi-Do 443-742 (KR)

**Representative:** Zijlstra, Robert Wiebo Johan  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 13 March 2009  
refusing European patent application  
No. 04255157.2 pursuant to Article 97(2) EPC.

**Composition of the Board:**

**Chairman:** T. Kriner  
**Members:** M. Alvazzi Delfrate  
A. Pignatelli

## Summary of Facts and Submissions

- I. By decision posted on 13 March 2009 the examining division refused European patent application No. 04 255 157.2.

The examining division held that the requests then on file either comprised subject-matter which lacked novelty in view of

D2: WO- A- 03/030227,

or did not comply with Articles 123(2) and 84 EPC.

- II. The appellant lodged an appeal against this decision on 20 May 2009, paying the appeal fee on the same day. The statement setting out the grounds for appeal was filed on 22 July 2009.

- III. Oral proceedings before the Board of Appeal were held on 24 May 2011.

- IV. The appellant requested that the decision under appeal be set aside and that a patent be granted in the following version:

claims 1 to 9 filed during the oral proceedings before the Board;

description pages 1, 3, 4, 7, 9, 13-18 as originally filed,

pages 5, 6, 8, 10, 11, 12 filed during the oral proceedings before the Board,

pages 2, 2a filed on 18 March 2008;

Figures 1 to 5 as published.

V. Claim 1 reads as follows:

"A method of producing compound semiconductor nanocrystals by a wet chemistry method which comprises: synthesizing the semiconductor nanocrystals in a reaction mixture comprising a solvent and a dispersant, said solvent and dispersant each coordinating to the surface of the nanocrystals; adding a further organic solvent to the reaction mixture to quench the reaction, thereby causing the dispersion of semiconductor nanocrystals in a colloidal state in said further organic solvent; and separating the semiconductor nanocrystals from the further organic solvent by centrifugation; characterized by: dispersing the separated semiconductor nanocrystals in a further solvent selected from toluene, chlorobenzene, hexane, octane, methylenechloride, chloroform, ethanol, propanol, butanol and dimethylformamide; and adding sodium borohydride to the separated semiconductor nanocrystals dispersed in said further solvent to improve the luminescent efficiency of the dispersed semiconductor nanocrystals by surface-treating said semiconductor with the sodium borohydride."

VI. In addition to D2 the following document is also relevant for the present decision:

D1: Talapin D.V. et al. "Highly luminescent monodisperse CdSe and CdSe/ZnS nanocrystals synthesized in Hexadecylamine-Trioctylphosphine Oxide-

Trioctylphosphine Mixture", NANO LETTERS, vol. 1, no. 4, 2001, pages 207- 211.

### Reasons for the Decision

1. The appeal is admissible.
2. The present claims do not comprise any of the features underlying the objections of the first-instance decision with respect to Articles 84 and 123(2) EPC.
3. Novelty
  - 3.1 D1 discloses on page 208, left-hand column, a method of producing compound semiconductor nanocrystals (CdSe) which comprises synthesizing the semiconductor nanocrystals in a reaction mixture comprising a solvent (mixture TOP-TOPO) and a dispersant (HDA), said solvent and dispersant each coordinating to the surface of the nanocrystals; adding a further organic solvent (toluene) to the reaction mixture to quench the reaction , thereby causing the dispersion of semiconductor nanocrystals in a colloidal state in said further organic solvent. The dispersed semiconductor nanocrystals can be passivated with a ZnS or alkylamine shell (see abstract and page 210).

However, D1 does not disclose dispersing the separated semiconductor nanocrystals in a further solvent selected from toluene, chlorobenzene, hexane, octane, methylenechloride, chloroform, ethanol, propanol, butanol and dimethylformamide, and adding sodium borohydride to the separated semiconductor nanocrystals

dispersed in said further solvent to improve the luminescent efficiency of the dispersed semiconductor nanocrystals by surface-treating said semiconductor with the sodium borohydride

- 3.2 D2 discloses a method of producing compound semiconductor nanocrystals (see page 3, lines 7-14 and page 5, lines 5-17) which comprises synthesizing the semiconductor nanocrystals in a reaction mixture comprising a solvent and a dispersant, said solvent and dispersant each coordinating to the surface of the nanocrystals (see page 12, line 22- page 13, line 25); and quenching the reaction.

Although D2 mentions sodium borohydride (see page 16, lines 19-30), this compound is used as a reducing agent to promote the reaction of synthesis and not, as in the method according to present claim 1, to surface-treat the separated semiconductor nanocrystals.

- 3.3 Therefore, the subject-matter of claim 1 is novel.

4. Inventive step

- 4.1 D1, which discloses a process for the production of semiconductor nanocrystals comprising the passivation of their surface to improve the luminescent efficiency (see abstract), can be considered as the most relevant prior art, since it discloses a process having most of the relevant technical features in common with the claimed invention.

- 4.2 Starting from the method disclosed in D1, the object underlying the claimed invention can be seen in

providing a method which provides nanocrystals whose luminescent efficiency is improved without affecting the luminescent properties, in particular without broadening the luminescent wavelength distribution (see paragraphs [0009] and [0005] of the application as published).

This object is achieved by the steps according to the characterising portion of claim 1 (see examples 1 to 4).

- 4.3 None of the available documents of the prior art discloses these steps, let alone with a view to achieving the object above. Accordingly, the subject-matter of claim 1 also involves an inventive step.

**Order**

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

1. The decision under appeal is set aside.
  
2. The case is remitted to the first-instance department with the order to grant a patent on the basis of the following documents:

claims 1 to 9 filed during the oral proceedings before the Board;

description pages 1, 3, 4, 7, 9, 13-18 as originally filed, pages 2, 2a filed on 18 March 2008, pages 5, 6, 8, 10, 11, 12 filed during the oral proceedings before the Board;

Figures 1 to 5 as published.

The Registrar:

The Chairman:

V. Commare

T. Kriner