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**Datasheet for the decision  
of 7 March 2022**

**Case Number:** T 2660/17 - 3.4.03

**Application Number:** 12708921.7

**Publication Number:** 2678881

**IPC:** H01L21/02, H01L33/00

**Language of the proceedings:** EN

**Title of invention:**

SEMICONDUCTOR DEVICE AND FABRICATION METHOD

**Applicant:**

UCL BUSINESS LTD

**Headword:**

**Relevant legal provisions:**

EPC Art. 123(2)

RPBA Art. 12(4)

**Keyword:**

Amendments - intermediate generalisation  
Request filed with grounds of appeal - request in substance  
identical to request replaced in first instance proceedings

**Decisions cited:**

**Catchword:**



**Beschwerdekammern**

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**Case Number: T 2660/17 - 3.4.03**

**D E C I S I O N**  
**of Technical Board of Appeal 3.4.03**  
**of 7 March 2022**

**Appellant:**  
(Applicant)

UCL Business Ltd  
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**Representative:**

J A Kemp LLP  
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**Decision under appeal:**

**Decision of the Examining Division of the  
European Patent Office posted on 29 June 2017  
refusing European patent application No.  
12708921.7 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman**

T. Häusser

**Members:**

M. Stenger

D. Prietzel-Funk

## **Summary of Facts and Submissions**

- I. The appeal concerns the decision of the Examining Division to refuse European patent application No. 12 708 921. In the contested decision, the Examining Division found that the independent claims of the main request and of the auxiliary request then on file were not clear as required by Article 84 EPC and contravened the requirements of Article 123(2) EPC (points 18 and 21 of the contested decision).

At the end of the decision, the Examining Division also made some additional comments regarding lack of inventive step of the claims of both requests (pages 11 to 15). These comments correspond at least in part to the objections with respect to lack of inventive step comprised in the summons to oral proceedings (point 3 and sub-points).

- II. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of a main request or according to one of first to third auxiliary requests, all filed with the statement setting out the grounds of appeal (section 2.1 of the grounds of appeal).
- III. In a communication preparing the oral proceedings, the Board indicated its preliminary opinion that the main request and the first auxiliary request did not comply with Articles 84 and 123(2) EPC. The Board further indicated that the admission of the second and third auxiliary requests was unlikely and made some comments with respect to inventive step for these requests.

IV. The appellant did not reply in substance to the preliminary opinion of the Board. Instead, with letter dated 10 November 2021, they withdrew their request for oral proceedings. Hence, the oral proceedings appointed for 23 November 2021 were cancelled.

V. Claim 1 of the main request has the following wording (labeling a), b), ... added by the Board):

- a) *A method of fabricating a semiconductor device that comprises a semiconductor heterostructure of gallium arsenide on germanium, the method comprising the steps of:*
- b) *providing a substrate having a surface comprising germanium;*
- c) *protecting the surface comprising germanium from arsenic in an environment having a partial pressure of arsenic less than  $133 \times 10^{-8}$  Pa ( $10^{-8}$  torr), by a shutter directly covering the surface;*
- d) *epitaxially growing a layer of gallium on the surface immediately after said surface is exposed by not applying the shutter;*
- e) *epitaxially growing a layer of gallium arsenide on the gallium covered surface; and*
- f) *providing a further heterostructure that comprises a quantum dot on the layer of gallium arsenide;*
- g) *wherein said germanium surface is a (001) oriented germanium substrate off-cut by between  $1^\circ$  and  $6^\circ$  towards the [110] direction, and*
- h) *wherein the quantum dot is provided between an upper cladding layer and guiding layer and a lower cladding layer and guiding layer.*

VI. Claim 1 of the first auxiliary request differs from claim 1 of the main request in that it comprises, at

the end of feature d), the additional feature i) as follows:

i) *such that the surface is substantially free of arsenic just before the layer of gallium is grown on the surface*

VII. Claim 1 of the second auxiliary request has the following wording (labeling j), k), ... added by the Board):

j) *A method of fabricating a semiconductor heterostructure of gallium arsenide on germanium comprising the steps of:*

k) *protecting a surface comprising germanium from arsenic in an environment having a partial pressure of arsenic less than  $10^{-8}$  torr, by a shutter directly covering the surface;*

l) *epitaxially growing a layer of gallium on the said surface immediately after said surface is exposed by not applying the shutter;*

m) *and epitaxially growing a layer of gallium arsenide on the gallium covered surface.*

Feature l) corresponds to feature d) and feature m) corresponds in substance to feature e).

VIII. Claim 1 of the third auxiliary request differs from claim 1 of the second auxiliary request in that it comprises, at the end of feature l), feature i) as defined above.

IX. The relevant arguments of the appellant may be summarized as follows:

Providing the quantum dot of the further heterostructure between an upper cladding layer and guiding layer and a lower cladding layer and guiding layer was not specific to the particular embodiment shown in Figure 3 of the application. The skilled person would readily understand that this feature was applicable to embodiments beyond the specific layer structure of the embodiment shown in Figure 3. It was thus not necessary nor appropriate to incorporate further features of this particular embodiment, such as a specific layer structure, into the respective independent claim of the main request and the first auxiliary request. Instead, a certain degree of generalisation of the claimed features was permitted, provided that the claimed generalised features as a whole allowed the problem to be solved.

### **Reasons for the Decision**

1. The appeal is admissible.
2. Main request, Article 123(2) EPC

The objection of the Examining Division relating to Article 123(2) EPC of the main request then on file concerns an intermediate generalisation with respect to the features relating to the quantum dots and the cladding and guiding layers of claim 1 then on file. These features are comprised in claim 1 of the present main request as well and were labeled features f) and h) by the Board (see above). In the contested decision, they were labeled D and E.

2.1 Quantum dots are mentioned throughout the original application as a whole only in relation to quantum dot lasers (which always comprise a multitude of quantum dots) and there is no basis in the original application under Article 123(2) EPC for providing a heterostructure comprising a *single* quantum dot as encompassed by feature f) of claim 1 of the main request ("comprises a quantum dot").

2.2 Further, whereas quantum dot lasers are mentioned in the original claims (original claims 8 and 12), the guiding and the cladding layers are not mentioned therein.

A basis for feature h) of claim 1 of the main request defining such layers can thus possibly be found only in the original description, in combination with the figures. The cladding layers are mentioned therein on page 5, lines 7 to 8, page 6, line 2 and page 7, line 6. The guiding layers are mentioned only on page 5, line 8.

Both kinds of layers are thus only mentioned in relation to the fabrication of standard 5-layer 1300-nm InAs/InGaAs DWELL quantum-dot lasers, i.e. in relation to the embodiment shown in Figure 3 (see page 5, lines 6 to 7 of the description). In such a device, the function of these layers is to assist/enable the laser to emit laser light.

In other quantum dot devices that do not emit light, for example quantum dot solar cells, quantum dot computing devices or quantum dot single electron transistors, cladding and guiding layers could not have the same function. Instead, in such devices, cladding and guiding layers would necessarily have different functions than in a DWELL quantum dot laser.



Hence, there is a functional relationship between the cladding and guiding layers and the type of quantum dot device described with respect to Figure 3 of the application. Thus, the provision of the cladding and the guiding layers in the embodiment of Figure 3 of the application is specific to this embodiment, contrary to the argument of the appellant.

Further, the application is silent about the functions or the advantages cladding and guiding layers would have with such other quantum well devices (not emitting light). Hence, the skilled person would not have readily understood from the application that the cladding and guiding layers could be applied to embodiments beyond the one shown in Figure 3, contrary to the submission of the appellant.

Instead, with respect to the application as originally filed, the skilled person would, by means of feature h), be presented with the additional information that cladding and guiding layers may be used with *any* quantum-dot heterostructure, including single quantum dot heterostructures as encompassed by feature f).

The Board accepts that "a certain degree of generalisation of the claimed features may be permitted" as argued by the appellant. Nevertheless, it follows from the above that the extraction of features f) and h) in isolation from the embodiment of Figure 3, in particular in isolation from the feature that the quantum device emits light, in particular being a quantum dot laser, amounts to an intermediate generalisation and does therefore not comply with the requirements of Article 123(2) EPC, as set out by the Examining Division.

3. First auxiliary request

Claim 1 of the first auxiliary request also comprises features f) and h). Hence, the same arguments as for claim 1 of the main request apply. Thus, claim 1 of the first auxiliary request does not comply with the requirements of Article 123(2) EPC, either.

4. Second and third auxiliary requests

4.1 Second auxiliary request

Features b), f), g) and h) relating to the substrate, the surface, the further heterostructure, the quantum dot and the cladding and guiding layers (labelled A, D, C, and E, respectively, in the contested decision) were introduced, in claim 1 of the main request and of auxiliary request 1 filed with letter dated 21 March 2017 to overcome, in particular, the inventive step objections raised by the Examining Division in the summons to oral proceedings. However, these features are not present in the claims according to the second auxiliary request.

Further, another feature (labeled feature B in the contested decision) was also introduced in claim 1 of the main request and of auxiliary request 1 filed with letter dated 21 March 2017 to overcome the inventive step objections raised in the summons to oral proceedings. This feature, however, is not present in the claims according to any of the present requests, in particular the second auxiliary request.

In the absence of these features, claim 1 of the second auxiliary request differs from claim 1 of the request

filed with letter dated 18 May 2015 only in that the Germanium surface is protected *from arsenic* by a shutter *directly* covering the surface and that the surface is exposed *by not applying the shutter*.

Neither claim 1 of the second auxiliary request nor the application as a whole comprises any particular details as to which properties of the shutter would provide the protection *from arsenic* by *directly* covering the surface (e.g., geometrical shape, possible seals, position with respect to the sources, distance to the Ge surface). No such details are given for the shutter used to create the experimental data attached to the grounds of appeal, either.

It is thus not clear whether this feature implies any (and if yes, which) restriction of the claimed subject-matter. Further, that a surface covered by a shutter is exposed *by not applying the shutter* is inevitable.

Thereby, claim 1 of the second auxiliary request corresponds in substance to claim 1 of the request as filed with letter dated 18 May 2015 on which the first instance summons to oral proceedings were based. This request was replaced before the oral proceedings with letter dated 21 March 2017 by a main request and an auxiliary request, the independent claims of which both comprise features b), f), g) and h).

It follows therefrom that the present second auxiliary request in substance amounts to the resubmission of a previously withdrawn request which is under the present circumstances inadmissible.

For these reasons, the Board does not admit the second auxiliary request into the proceedings under Article 12(4) RPBA 2007 (see *Case Law of the Boards of Appeal of the EPO*, 9th ed., V.A.4.11.4 c) and d)).

#### 4.2 Third auxiliary request

Claim 1 of the third auxiliary request comprises, with respect to claim 1 of the second auxiliary request, additional feature i) as defined above.

This additional feature defines a result to be achieved by a relative term ("the surface is substantially free of arsenic"). Thus, similar to what is set out above for claim 1 of the second auxiliary request, it is not clear whether this feature implies any (and if yes, which) restriction of the claimed subject-matter.

Thereby, for the reasons set out above with respect to the second auxiliary request, the present third auxiliary request in substance also amounts to the resubmission of a previously withdrawn request.

Thereby, the Board does not admit the third auxiliary request into the proceedings under Article 12(4) RPBA 2007, either (see *Case Law of the Boards of Appeal of the EPO*, 9th ed., V.A.4.11.4 c) and d)).

#### 5. Conclusions

The main request and the first auxiliary request do not comply with the requirements of Article 123(2) EPC. The second and the third auxiliary requests are not admitted into the proceedings. Thus, the appeal must fail.

It is therefore not necessary to discuss the other objections raised in the contested decision and the preliminary opinion of the Board.

## Order

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

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

T. Häusser

Decision electronically authenticated