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**Datasheet for the decision
of 13 October 2022**

Case Number: T 0997/19 - 3.4.03

Application Number: 11797657.1

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H01L51/00, H01L51/44,
B82Y15/00, H01L29/16

Language of the proceedings: EN

Title of invention:

APPARATUS AND METHOD FOR SENSING PHOTONS

Applicant:

Nokia Technologies Oy

Headword:

Relevant legal provisions:

EPC Art. 56

Keyword:

Inventive step - (no) - no ex post facto analysis

Decisions cited:

Catchword:



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 0997/19 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 13 October 2022

Appellant: Nokia Technologies Oy
(Applicant) Karakaari 7
02610 Espoo (FI)

Representative: Espatent Oy
Kaivokatu 10 D
00100 Helsinki (FI)

Decision under appeal: **Decision of the Examining Division of the
European Patent Office posted on 15 November
2018 refusing European patent application No.
11797657.1 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman T. Häusser
Members: M. Stenger
G. Decker

Summary of Facts and Submissions

- I. The appeal concerns the decision of the Examining Division to refuse European application No. 11 797 657. In the contested decision, the Examining Division set out that the subject-matter of claims 1 and 10 of the then main request was not inventive under Article 56 EPC starting from D1 combined with D2 or starting from D3 combined with D4. Relating to the then auxiliary request, the Examining Division set out that the requirements of Article 123(2) EPC were not fulfilled for claims 1 and 9 and that the subject-matter of claims 1 and 9 was not based on an inventive step for the reasons given for claims 1 and 10 of the main request.
- II. The documents referred to in the contested decision are the following:
- D1 US 2004/0259010 A1
- D2 MUELLER T ET AL: "Graphene photodetectors for high-speed optical communications", NATURE PHOTONICS, NATURE PUBLISHING GROUP, UK, vol. 4, 1 May 2010 (2010-05-01), pages 297-301, XP002639966, ISSN: 1749-4885, DOI: 10.1038/NPHOTON.2010.40
- D3 WO 2006/058452 A1
- D4 RYZHII V ET AL.: "Terahertz and infrared photodetection using p-i-n multiple-graphene-layer structures", J.APPL.PHYS, vol. 107, no. 054512, 9 March 2010 (2010-03-09), XP012133637
- III. The appellant had requested in writing that the contested decision be set aside in its entirety and that a patent be granted according to the main request on file or to an auxiliary request filed with the

grounds of appeal. The appellant had further requested oral proceedings in case the Board of Appeal was minded not to allow the (other) requests of the appellant.

- IV. In its communication preparing the oral proceedings before the Board, the Board indicated its understanding of the expression "main request on file" as referring to the main request on which the contested decision was based.

In the same communication, the Board further indicated its preliminary opinion that the subject-matter of claim 1 of the main request as well as of claim 1 of the auxiliary request lacked an inventive step.

- V. With a letter dated 6 May 2022, the appellant withdrew its request for oral proceedings. It did not contest the Board's understanding of the requests on file.

- VI. Claim 1 of the main request has the following wording:

An apparatus, comprising:

a plurality of photon sensing layers arranged on top of each other; and

an intermediate layer between each two adjacent sensing layers, the sensing layers being of graphene, and each intermediate layer being configured to prevent a respective color component of light from proceeding into the photon sensing layer next to it.

- VII. Claim 1 of the auxiliary request differs from claim 1 of the main request by the additional feature at its end

; wherein at least one of the plurality of photon sensing layers comprises ten or more graphene sub-layers

VIII. The appellant argued essentially as follows:

The claimed subject-matter of the main request involved an inventive step starting from document D1 or document D3 as closest state of the art combined with documents D2 and D4. The analysis of the Examining Division was based on hindsight. The skilled person would not have considered graphene, which was disclosed in both D2 and D4 only in combination with specific structural elements, as a suitable material for photodetectors in a general manner and therefore as material for the photon sensing layers of D1 or D3.

The additional restrictions of the auxiliary request concerning the number of graphene sublayers were not disclosed in any of documents D2 and D4. In view of these documents, the skilled person would not even have tested a number of graphene sublayers higher than seven as disclosed in D4.

Reasons for the Decision

1. The appeal is admissible.
2. Closest prior art

The Examining Division set out that both D1 and D3 were suitable to represent the closest state of the art. The appellant did not contest this finding. The Board sees no reason to disagree.

3. Main request, D1

In the wording of claim 1 of the main request, D1 discloses (references in parentheses referring to D1):

An apparatus, comprising: a plurality of photon sensing layers (5r, 5g, 5b) arranged on top of each other (Figure 2); and an intermediate layer (9b, 9g) between each two adjacent sensing layers (5r, 5g, 5b), and each intermediate layer (9b, 9g) being configured to prevent a respective color component of light from proceeding into the photon sensing layer next to it (Figure 2),

as set out by the Examining Division (contested decision, section II.1.1).

3.1 Distinguishing features

The subject-matter of claim 1 thus differs from D1 in

- the sensing layers being of graphene,

as set out by the Examining Division. The Board notes that the appellant did not contest this finding.

3.2 Technical effect / objective technical problem

The Examining Division formulated the objective technical problem as being the choice of an alternative light sensing material. In line therewith, the appellant formulated the objective technical problem as providing an alternative photosensitive material. The Board sees no reason to disagree.

3.3 Inventive step, starting from D1

3.3.1 Other documents

The Examining Division and the appellant further agreed that the skilled person would have been aware of D2. The Board concurs. In addition, the skilled person would also have been aware of D4.

3.3.2 Examining Division

The Examining Division set out that the skilled person knew from D2 that graphene was a suitable material for photodetectors in a general manner and that they would hence consider graphene as material for the photon sensing layers of D1.

3.3.3 Arguments of the appellant

The appellant submitted that on the basis of D2, the skilled person would have been aware that graphene could be used as photosensitive material only in some (particular) applications, especially applications like the photodetector of D2. There was no teaching in D2 as to wider applicability of graphene (grounds of appeal, page 3, last paragraph) and there was no pointer, neither in D1 nor D2, that would have prompted the skilled person to actually combine the teachings of these documents.

Instead, the device of D2 required a specific electrode structure which was essential to the functioning of the graphene layer, including electrodes of different metals. D4 also disclosed a specific read-out structure. A graphene layer would thus not work with the wiring of D1, and its use in the device of D1 would require a complete overhaul of the wiring. Thus, although the skilled person could have modified the

electrode structure of the closest prior art D1, they would have had no reason to do so.

Furthermore, the skilled person would have learnt from D2 only that graphene could be used as a photosensitive material in a device with a single photosensitive layer. The same applied to the disclosure of D4. They would have had no incentive to replace (all) the photosensitive layers of D1 by a graphene layer, in particular since there was no guarantee to succeed.

For these reasons, the analysis of the Examining Division was based on hindsight. Instead, the subject-matter of claim 1 involved an inventive step within the meaning of Article 56 EPC.

3.3.4 Opinion of the Board

The Board notes that the imaging device of the photoconductive-layer-stacked type (see D1, paragraph [5]) is disclosed in D1 in a *general* manner, not relying on any particular material to be used for the photoconductive / optical-electrical conversion layers (see paragraphs [9] to [12]). The photosensitive material used in the embodiment of Figure 2 of D1 (see paragraph [22]) is mentioned as an example only. The Board finds this to be a pointer to consider all materials that might be suitable for optical-electrical conversion in an image sensing / photon sensing application.

The Board is of the opinion that this pointer leads the skilled person directly to considering solutions of the objective technical problem as formulated by the appellant (see point 3.2 above).

In the abstract and the first paragraph of the description, D2 discloses in a *general* manner that graphene is suitable to be used in photodetecting applications, leading potentially to high detection speeds higher than 500 GHz and an operational wavelength range spanning from 300 nm to 6 micrometers, "revealing the great potential of graphene in numerous applications related to light detection". Thus, contrary to the appellant's argument, D2 discloses a wider applicability of graphene in photodetector applications, going beyond the particular photodetector described with respect to Figure 1.

It follows that the skilled person would have learnt from D2 in a *general* manner that graphene is a material that is suitable for optical-electrical conversion in a light detection, i.e. photon sensing, application. Furthermore, the skilled person would have taken the same teaching from D4 (see e.g. the abstract). Hence, they would have considered using graphene as material for the photoconductive / optical-electrical conversion layers in the photoconductive-layer-stacked type photodetector of D1.

The Board notes that, although the particular photodetector described in D2 (and in D4) has only one sensing layer, there is nothing in the disclosure of D1 or D2 (or D4) that would have dissuaded the skilled person from considering using graphene as material for each single sensing layer in the photodetector of D1.

The Board accepts that D2, when describing the photodetector depicted in Figure 1, provides some details concerning the structure of the electrodes used. However, the Board does not see why this would deter the skilled person from using graphene in a

stacked device according to D1. Instead, the Board is convinced that the skilled person not only *could*, but also *would* have used the details given in D2 during the implementation of such a stacked device with graphene layers. The same applies to D4.

The Board notes that claim 1 is defined in broad terms. Furthermore, the application as a whole does not address any particular problems of implementation and does not go beyond merely *suggesting* the use of graphene layers as sensing layers in a photoconductive-layer-stacked type photodetector. The application is also silent on any particular advantage of using graphene as sensing layers in a stacked configuration, or any technical prejudice that would have to be overcome by the skilled person when doing so. Consequently, the skilled person, by merely considering to use graphene as set out above, would have arrived at a configuration falling within the subject-matter of claim 1 of the main request.

Thus, starting from D1 and considering that graphene layers are suitable to be used as sensing layers in light detection applications as disclosed e.g. in D2 and D4, the subject-matter of claim 1 of the main request is not inventive under Article 56 EPC, without hindsight and contrary to the submissions of the appellant.

4. Auxiliary request, claim 1, inventive step

The Board accepts that the particular photodetector described with reference to Figure 1 of D2 uses bi-layer graphene, as submitted by the appellant. However, single- and tri-layer graphenes are also mentioned (page 297, left column, last paragraph).

Furthermore, although D4 mentions 7-layer graphene for small dimensions (page 054512-3, right column, last paragraph) as noted by the appellant, graphene layers with many more sub-layers of up to 100 are also disclosed in that document (see, for instance, the paragraph between the formulae (19) and (20)).

Therefore, the selection of the number of graphene sub-layers per graphene layer is not more than a routine measure taken by the skilled person when designing the graphene layers to have the required sensitivity in the desired spectral range, in line with what the Examining Division set out.

Thus, an inventive step under Article 56 EPC cannot be acknowledged on the basis of the additional feature of independent claim 1 of the auxiliary request.

5. To summarise, none of the requests on file fulfills the requirements of the EPC. Thus, the appeal must fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

T. Häusser

Decision electronically authenticated