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D E C I S I O N
of 30 March 2006

Case Number: T 0858/03 - 3.4.02

Application Number: 93308432.9

Publication Number: 0594453

IPC: G03G 5/082

Language of the proceedings: EN

Title of invention:
Process and apparatus for producing a light-receiving member

Patentee:
CANON KABUSHIKI KAISHA

Opponent:
AEG Elektrofotografie GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Main and auxiliary request: inventive step: no"

Decisions cited:
-

Catchword:
-

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Case Number: T 0858/03 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 30 March 2006

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 6 June 2003 revoking European patent No. 0594453 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: A. Klein
Members: M. Stock
C. Rennie-Smith

Summary of Facts and Submissions

I. The appellant and patent proprietor lodged an appeal against the decision of the opposition division revoking European patent number 0 594 453 (application number 93 308 432.9).

II. Opposition was filed against the patent as a whole and based on the ground under Article 100(a) EPC that the subject-matter of the patent is not new and does not involve an inventive step; see Article 52(1) EPC in connection with Articles 54(1) and 56 EPC, respectively.

The opposition division concluded that the subject-matter of the independent claims, namely claim 1 as amended and claims 32 and 38 as granted, did not involve an inventive step.

Reference was made to the following documents:

El: EP-A-0 154 160

E8: 19th IEEE Photovoltaic Specialists Conference - 1987, pages 695 to 698, H. Curtins et al., "High-Rate Deposition of Hydrogenated Amorphous Silicon by the VHF-GD-Method"

E12: Plasma Chemistry and Plasma Processing, vol.7, no.3, 1987, pages 267 to 273, H. Curtins et al., "Influence of Plasma Excitation Frequency for a-Si:H thin Film Deposition"

E13: DE-A-36 10 076

In particular, the opposition division considered that the subject-matter of claim 1 was obvious from a combination of E13 with E12 or E8.

III. With the Grounds of Appeal the appellant and proprietor requested maintenance of the patent in amended form on the basis of amended claims 1 to 33 according to a main request, or alternatively on the basis of claims 1 to 31 according to an auxiliary request. Proprietor's arguments can be summarised as follows:

It has been found that a significant improvement in image quality, after prolonged use, can be achieved using VHF plasma-assisted deposition (glow discharge) for depositing layers constituting the light-receiving member. Such deposition results in improvement in the interfacial state of the interface between adjacent layers and the consequence of this is improved durability of the light-receiving member and consequential improvement in the quality of images produced after prolonged use.

As can be seen from Table 15 of the patent, it is found that the light receiving member, formed with a frequency of 51 to 250 MHz, improved the characteristics after duration test, compared with the light receiving member formed with a frequency of 13.56 MHz. This is attributed to improvement of the electrophotographic characteristics by modifying mainly the interface region.

The identification in the appealed decision that in E13 the time of deposition is a problem, the deduction that E8 or E12 in fact show an increase of the deposition

rate by comparison with E13, and the conclusion it would be obvious to combine the teachings of E13 with the teaching of either E8 or E12, are all based on a false premise.

The rate of deposition of 25 µm in 3 hours disclosed in E13, Example 1, can be expressed as a rate of 23.1 Å/s, which clearly lies within the target range identified in E12. Notably, this is in fact faster, and not significantly slower, than the maximum processing speed reported in E12 of 21 Å/s obtained at 70 MHz.

It is clear from the foregoing that the deposition rate in E13 is within the desired target range and it follows accordingly that the skilled person would have no compelling incentive to seek further reduction. Even if the skilled person were still to seek a faster rate, it is not apparent that he would find a solution in either of E8 or E12 which do not disclose higher deposition rates.

Dark current can also be minimised in E13 and is not a problem. The skilled person starting from E13 would have no incentive to seek a solution elsewhere. Resistance to peeling, i.e. adhesion, is also considered in E13. It is found that adhesion is excellent for a surface layer of amorphous carbon hydride up to a hydrogen content of 40 atomic %. It follows that starting from E13 the person of skill in the art would not find peeling a problem and would not need to seek a solution outside of document E13.

It follows from the above that the skilled person would have no reason for combining the disclosure of document

E13 with the teachings of either of documents E8 or E12. Furthermore, in the case of E13 the user would experience flawed images after prolonged use. In seeking a solution to this problem, the skilled person would find no assistance from the prior art. Indeed, the skilled person would find no solution to this problem set out in either of documents E8 or E12.

In addition to the main request, the claims in the auxiliary request also include mention of a bias exceeding self-bias, the excess value bias being specified within a defined range. The provision of such excess bias results in improved control, improved quality of the films and, in particular, an improvement in the interfacial state at the interface between adjoining layers.

Bias is considered in document E13 where it is stated that in order to control the quality of films to be formed, an external bias can be applied thereto. In the case of an RF discharge, a bias voltage is generated automatically. The applied bias is not evaluated and values of bias voltage exceeding "auto-bias" cannot be deduced from E13. Only the limits of value of "auto-bias" are given in E13. The specified advantage of applying bias in excess of "auto-bias", and by the amount in the range given, is not disclosed.

IV. The opponent and respondent has requested that the appeal be dismissed. In connection with the auxiliary request of the appellant it has mentioned the following documents:

E16: EP 0 408 966 A2

E17: DE 40 39 930 A1

E18: DE 38 14 652 A1

E19: US 5 059 502 and English abstract of corresponding JP 02 132 457

E20: EP 0 421 430 A2 (numbered by the Board)

Opponent's arguments can be summarised as follows:

In addition to the preamble of claim 1 according to the main request, E13 discloses gases falling under feature (a) of the characterising portion. The selection of gases according to feature (b) is obvious from E13.

A process according to the preamble of claim 1, employing RF energy for deposition, is also known from E1. Reaction gas mixtures of silane, methane, ammonia, nitrogen and oxygen are used for the deposition of the barrier layers.

There is no concrete disclosure of the materials recited in claim 2 according to the main request in the patent specification. Therefore claim 2 is not admissible under Article 123 EPC. However, the materials recited in claim 2 can obviously be produced by the gases mentioned in E1.

The subject-matter of new claim 33 infringes Article 123(3) EPC, since its subject-matter does not appear in the claims as granted and original claims 36 to 38 related to a bias have not been searched.

Moreover, new claim 33 is related to subject-matter (bias) which has no connection with features (a) and (b) of claim 1. Thus, claim 33 is directed to an *aliud* which is not admissible under Article 123(3) EPC.

Claim 1 according to the auxiliary request has been supplemented by the features indicated in claim 33 of the main request. Since these features which are related to the difference of bias voltage and self-bias did not appear in the claims so far, Rule 86(4) EPC is contravened. However, claim 1 is also not supported by the description. Only from Figure 7 and Example 42 onwards are embodiments described which relate to the use of a bias voltage.

As far as patentability is concerned, E13 discloses an external bias voltage which is applied in order to control the quality of the deposited films. It is also mentioned in E13 that the high-frequency discharge generates a self-bias voltage varying over a wide range and that in addition an external bias can be applied.

Reference is made in this context to application E20 which has given rise to decision T 972/00. This application discloses the excitation of a plasma employing a frequency in the range 30-200 MHz, in particular 50-70 MHz, and selecting power and frequency such that the self-bias voltage is lower than 350 V and higher than 150 or 50 V.

If the auxiliary request were found admissible, documents E16 to E19 should be considered, disclosing bias-controlled high-frequency discharges.

Using a constant value throughout the formation of the barrier layer and the photoconducting layer according to claim 3 of the auxiliary request is "new matter" and nowhere disclosed in the documents as originally filed contrary to Article 123(2) and (3) EPC.

V. The proprietor has submitted an amended main claim to replace claim 1 of the main request. The sub-division of this claim was recast taking account of the disclosure of E1. The proprietor has reiterated its arguments in support of the claimed matter and provided detailed comments on the points raised by the opponent in his response.

VI. In an annex to the summons to attend oral proceedings requested by the parties, the Board made preliminary non-binding comments.

Claim 1 of the auxiliary request was amended by taking up features related to a bias voltage and self-bias voltage disclosed in the description. This substantial amendment appeared to go beyond what has been covered by the impugned decision. Therefore, if the conclusion were reached that the main request was not allowable and if the auxiliary request was admitted at this stage of the procedure, the Board might have to remit the case to the department of first instance in order to give the parties the opportunity to have their case considered by two instances, see Case Law of the Boards of Appeal of the EPO, 4th edition, 2001, chapter VII.D.14.1 at pages 551 and 552. Such remittal would, however, appear quite undesirable in view of the age of the patent in suit.

VII. In its letter dated 31 January 2006 the opponent indicated that it would not attend the oral proceedings.

VIII. With letter dated 28 February 2006 the proprietor renewed its request to maintain the patent on the basis of the main request. If the main request were not allowable, it requested that the auxiliary request be held admissible and the opportunity to be heard in support of this request.

IX. Oral proceedings took place on 30 March 2006 in the absence of the opponent. In the oral proceedings the proprietor requested to maintain the patent in amended form on the basis of the main or the auxiliary request.

Claim 1 according to the main request reads as follows:

"1. A process of producing an electrophotographic light-receiving member comprising a substrate (101) and a light-receiving layer (100) comprising a blocking layer (102) provided on the substrate and a photoconductive layer (103) provided on the blocking layer, the blocking layer comprising a non-monocrystalline material comprising silicon atoms as matrix, and the photoconductive layer comprising a non-monocrystalline material comprising silicon atoms as matrix and not more than 1 atomic % of at least one kind of atoms selected from the group consisting of carbon atoms, oxygen atoms and nitrogen atoms, which process is performed by depositing the blocking layer on the substrate and depositing the photoconductive layer on the blocking layer in each case by plasma-assisted CVD wherein respective starting material gases

are decomposed in a reaction chamber using electromagnetic radiation; and

the starting material gas ambient for depositing the blocking layer includes (a) at least one material gas selected from silicon hydrides or alkyl silicides, and (b) at least one material gas selected from saturated hydrocarbons, carbon fluorides, O_2, 0_3, CO, $C0_2$, N_2, NH_3, NO, NO_2, N_20, N_20_3, N_20_4 or N_2O_5;

characterised in that:

the electromagnet radiation, used in each case, is of VHF frequency of from 51 MHz to 250 MHz."

Claim 1 according to the auxiliary request reads as follows:

"1. A process of producing an electrophotographic light-receiving member comprising a substrate (101) and a light-receiving layer (100) comprising a blocking layer (102) provided on the substrate and a photoconductive layer (103) provided on the blocking layer, the blocking layer comprising a non-monocrystalline material comprising silicon atoms as matrix, and the photoconductive layer comprising a non-monocrystalline material comprising silicon atoms as matrix and not more than 1 atomic % of at least one kind of atoms selected from the group consisting of carbon atoms, oxygen atoms and nitrogen atoms, which process is performed by depositing the blocking layer on the substrate and depositing the photoconductive layer on the blocking layer in each case by plasma-assisted CVD wherein respective starting material gases are decomposed in a reaction chamber using electromagnetic radiation;

characterised in that:

the electromagnet radiation, used in each case, is of VHF frequency of from 51 MHz to 250 MHz; and and

said blocking layer and said photoconductive layer are deposited while applying, in each case, to a cathode adjacent to the substrate, a bias voltage V_1, which with respect to self-bias V_2 of the cathode under no application of said bias voltage V_1 is within the range of: $0 V < V_1-V_2 \leq 200 V$."

Reasons for the Decision

1. *Main request*

1.1 A process of producing an electrophotographic light-receiving member according to the preamble of claim 1 underlying the main request is disclosed in document E1 as correctly stated by the proprietor. In particular, E1 discloses the deposition of a blocking layer (14) on a substrate (12) and a photoconductive layer (16) on the blocking layer by decomposing starting gases using electromagnetic energy (microwave or RF energy), see page 11, lines 17 to 24, page 12, lines 25 to 27, page 30, lines 3 to 16 and claim 9.

1.2 Such a process of producing an electrophotographic light receiving member is also disclosed in E13 disclosing the use of a frequency of 13.56 MHz, see Figure 1, page 8, line 21 to page 9, line 35, and page 12, lines 16 to 22.

1.3 The subject-matter of claim 1 of the main request differs from the prior art described in E1 or E13 by the selection of a frequency range, namely 51 to 250 MHz. The objective problem solved by this selection addresses the improvement of the process in terms of quantity and quality of the obtained light-receiving members.

1.4 One such parameter affecting quantity always is the deposition rate. This issue is addressed in documents E8: "High-Rate Deposition of Hydrogenated Amorphous Silicon by the VHF-GD-Method"; and in E12: "Influence of Plasma Excitation Frequency for a-Si:H thin Film Deposition". The authors of E8 and E12, see abstract and Figure 1 in each document, report the results of measurements of the deposition rate in dependence on the frequency, and find a maximum rate at about 70 MHz, which is a factor of 5 to 8 larger than the rate at 13.56 MHz. Moreover, E20, see column 11, lines 7 to 26, discloses a plasma process for semiconductor processing employing frequencies greater than 13.56 MHz, in particular 30 to 200 MHz and more specifically 50 to 70 MHz, "selected to optimize processing the wafer". For chemical vapour deposition a frequency range of 100 to 200 MHz is selected, see E20, column 8, lines 19 to 31. Therefore it was obvious for the skilled person to employ frequencies disclosed in E8, E12 or E20 to optimise the processing in the method known from E1 or E10 and thus arrive at subject-matter comprising frequencies falling within the range defined in claim 1 of the main request.

1.5 The appellant argued in connection with the main request that the claimed subject-matter was based on the recognition that, when the blocking layer and the photoconductive layer are produced by decomposing the specified gas species at the specified frequency, the interface between the blocking layer and the photoconductive layer is of better quality and operational defects such as white dots, image smearing, ghost, and potential shift are eliminated or significantly reduced. This teaching is not only a bonus effect because the problem and the solution related to the interfacial state of the layers are not found in the prior art cited which is concerned with another problem and solution, namely to obtain a higher deposition rate. In fact, in documents E1 and E13 the deposition rate is satisfactory and there is no compulsive reason to consider other frequencies or to choose a particular frequency range. A frequency of 70 MHz is suggested in E8 and E12 being concerned with low dark current, which is not considered in E1 or E13. The prior art discloses the feasibility of the present invention only in the sense that the skilled person could have selected a frequency range, but there was no reason why the skilled person would have done so.

1.6 These arguments are, however, not accepted by the Board. It is evident from the cited documents that the frequency was a very important parameter influencing the chemical vapour deposition process. Reported is not only the influence on the deposition rate, as in E8 and E12, but also on various optimisation of the wafer as in E20, see column 8, lines 19 to 31. In particular "good deposition uniformity, high film purity and the appropriate level of film stress" are mentioned in E20,

see column 6, 39 to 46. Therefore it was not surprising for the skilled person that the frequency had an effect on the quality of an image obtained by a light receiving member employing a photoconductive layer and a barrier layer produced by CVD as in claim 1 according to the main request. Hence, the Board is convinced that the skilled person not only could have selected an appropriate frequency, but would have expected that the quality of the deposited layers depends upon a properly chosen frequency.

2. *Auxiliary request*

2.1 Claim 1 according to the auxiliary request, apart from being more general as regards the selection of starting material gases in the preamble than claim 1 of the main request, is more specific in the characterising portion as to the discharge conditions in that a selection of bias voltage with respect to the self-bias voltage is defined. The problem solved by the selection of the bias voltage is related to further optimisation of the film quality.

2.2 The fact that a glow discharge generates a self or auto-bias voltage is known, see e.g. E13, page 12, last paragraph, corresponding to the preamble of claim 1 according to the auxiliary request. It is also mentioned in the cited paragraph that an external bias can be applied in order to control the quality of the layers. The effect of a self-bias voltage in dependence on the frequency is also discussed in E20, see column 8, lines 19 to 31.

2.3 Furthermore document E19, see the abstract and column 9, line 42 to column 10, line 64, discloses a process of producing an electrophotographic member comprising an organic photoconductive layer formed on a substrate. A protective layer of carbon or a carbon-based material is formed on the photoconductive layer by plasma CVD and sputtering employing a discharge produced by a first alternating voltage of a high frequency (1 to 100 MHz) under the application of a DC bias generated by a second alternating voltage of a lower frequency (1 to 500 KHz). Values of the DC bias range from -10 to -600 Volt thus overlapping with the range defined in claim 1 of the auxiliary request.

2.4 In view of the fact that controlling the glow discharge of a CVD process by a bias exceeding the self-bias was known in general, see E13 and E19, it was obvious for the skilled person to carry out the CVD process discussed under point 1 above, under the application of such a bias exceeding self-bias and to determine appropriate values of this bias.

2.5 The appellant argued that a bias exceeding self-bias being specified within a defined range results in improved control, improved quality of the films and, in particular an improvement in the interfacial state of the layers. The advantage of applying a bias in excess of self-bias and by the amount specified was not obvious from the prior art cited.

2.6 The Board is, however, of the opinion that the skilled person was fully aware of the fact that a bias in excess of the self-bias provides further control of the

discharge and thus of the quality of the deposited layers with their influence on the image quality.

3. Therefore, while taking due account of the principal arguments of the appellant, it follows that the subject-matter of claim 1 according to the main and the auxiliary request does not meet the requirements of Article 52(1) EPC because this subject-matter does not involve an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl A. G. Klein