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D E C I S I O N
of 3 September 2001

Case Number: T 1087/97 - 3.4.1

Application Number: 89301344.1

Publication Number: 0331303

IPC: H01S 3/108

Language of the proceedings: EN

Title of invention:
Second harmonic generation

Applicant:
SONY CORPORATION

Opponent:
-

Headword:
Second harmonic generation/SONY CORPORATION

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes - after amendment)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1087/97 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 3 September 2001

Appellant: SONY CORPORATION
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 4 June 1997 refusing European patent application No. 89 301 344.1 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. Davies
Members: H. K. Wolfrum
U. G. O. Himmler

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal, received on 25 July 1997, against the decision of the Examining Division, dispatched on 4 June 1997, refusing European patent application 89 301 344.1 (publication No. 0 331 303). The prescribed fee was paid on 25 July 1997 and the statement setting out the grounds of appeal was received on 14 October 1997.

II. In the decision under appeal, the Examining Division held that the subject-matter of the claims according to a main request and an auxiliary request then on file did not involve an inventive step within the meaning of Article 56 EPC, having regard to the documents:

D1: FR-A-2 589 290; and

D2: WO-A-87/07446.

III. In a communication dated 27 April 2001, accompanying a summons to oral proceedings scheduled for 22 August 2001, the Board additionally made reference to the documents:

D3: W.J.Kozlovsky et al., Optics Letters, vol. 12, No. 12, December 1987, pages 1014-1016; and

D4: T.Baer, Journal of the Optical Society of America B (Optical Physics), vol. 3, No. 9, September 1986, pages 1175-1180.

IV. In reply to telephone conversations on 10 August 2001 and 16 August 2001 between the rapporteur and the appellant's representative, in which the Board gave

indications as to patentable subject-matter, the appellant filed on 15 August 2001 and 16 August 2001, respectively, a new request replacing all former requests on file. On the condition that the application could be granted on the basis of the new request, the request for oral proceedings was withdrawn.

V. The Board cancelled the oral proceedings by a notification of 16 August 2001.

VI. The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of the following documents :

Claims: No. 1 and 2 filed by letter dated 16 August 2001;

Description: pages 1, 2, 4, 5, 6, 8, 10, 12 to 15, 17 to 19, 22 to 26 and 28 filed by letter dated 15 August 2001,
pages 3, 4a, 7, 9, 11, 16, 20, 21 and 27 filed by letter dated 16 August 2001;

Drawings: sheets 1/6 to 6/6 as originally filed.

VII. Independent claim 1 reads as follows:

"*1. A second harmonic generator for generating a second harmonic laser light, comprising :*

a laser medium (2) for generating fundamental wave laser light provided within an optical resonator (CAV);

a non-linear optical crystal element (6) provided within the optical resonator
(CAV) for generating a second harmonic laser light; and

a birefringent element (7) further provided within the optical resonator (CAV);

wherein said fundamental wave laser light comprises two intrinsic polarization states (E_1, E_2) and the azimuth angle (è) at which the optical axis of the birefringent element (7) is inclined relative to the optical axis of the non-linear optical crystal element (6) and the relative phase shift (Ä) of said birefringent element (7) on the fundamental wave laser light are selected so as to prevent energy from being interchanged between said intrinsic states (E_1, E_2) through the generation of the second harmonic laser light;

characterised in that said laser medium (2), said birefringent element (7) and said non-linear optical crystal element (6) are closely laminated as one body with said birefringent element (7) being located between said laser medium (2) and said non-linear optical crystal element (6), in that the end surfaces (2A, 6B) of said body are convexly shaped and made reflective so as to form said optical resonator (CAV), and in that the reflective surface (6B) formed on the non-linear optical crystal element (6) is transmissive to the second harmonic laser light."

VIII. The appellant's submissions in support of its request may be summarized as follows:

The invention concerned a second harmonic generator exhibiting a stabilized output of the second harmonic laser light and having a miniaturized resonator structure. Due to a specific arrangement of the optical elements within the resonator, all elements could be integrated into a single monolithic body. The cited

prior art did not teach the claimed arrangement of the optical elements. Thus even a combination of the teachings of all cited documents would not have led the skilled person to the subject-matter of claim 1.

IX. In the contested decision, the Examining Division held that the skilled person, when confronted with the problem of miniaturizing a resonator, such as known from the closest prior art according to D1, would have readily realized that there were two possibilities of arranging the optical elements in the second harmonic generator, i.e. either as shown in D1 or as claimed in the present application, and that maintaining the order of the elements within the resonator as shown by D1 would not have allowed an integration of the resonator mirrors.

Reasons for the Decision

1. The appeal complies with the requirements of Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. *Amendments*

The Board is satisfied that the subject-matter of the amended claim 1 can be unambiguously derived from Figure 7 and the corresponding originally-filed description on page 26, line 2 to page 27, line 7. Claim 2 is based on originally-filed claim 3.

Thus, the amendments comply with the requirements of Article 123(2) EPC.

3. *Inventive step (Articles 52(1) and 56 EPC)*

3.1 Document D1 (cf. in particular Figure 1 with the corresponding description) discloses a second harmonic generator according to the preamble of claim 1 under consideration. The birefringent element used for stabilizing the output of the second harmonic laser light is formed by a quarter-wavelength plate for the fundamental wave laser light which has its optical axis inclined by an azimuth angle of 45° relative to the optical axis of the non-linear optical crystal element. According to claims 6 and 7 of D1, the quarter-wavelength plate is positioned in such a manner that it causes an exchange of the two intrinsic polarization states on dual passes of the fundamental wave laser light before the latter re-enters into the non-linear optical crystal and thus compensates for the phase shift of the fundamental wave laser light re-traversing the non-linear optical crystal. Accordingly, the birefringent element is shown in Figure 1 of D1 to be located between the non-linear optical crystal element and a concave output mirror which is transmissive to the second harmonic laser light.

3.2 Consequently, the subject-matter of claim 1 under consideration differs from the second harmonic generator known from D1 in that:

(a) the optical components of the resonator are closely laminated as one body, wherein

(b) reflective surfaces are formed on convexly-shaped end surfaces of the body, and

(c) the birefringent element is located between the

laser medium and the non-linear optical crystal element.

3.3 In view of these differences, the objective technical problem addressed by the invention is to provide a miniaturized second harmonic generator of stabilized output.

3.4 The idea of integrating the individual components of an optical resonator into a monolithic body is, as such, to be considered as conventional in the technical field at issue.

A specific example for such a structure is given by document D2 (cf. in particular Figure 1 with the corresponding description) relating to a laser resonator in which a laser medium with a reflecting surface on its back end, a Q-switch element and an output coupler (mirror) having an inner concave reflecting surface are laminated together by means of an adhesive.

Other examples for the integration of optical components were known from document D3 (cf. Figure 1) which discloses the idea of forming reflective coatings on convexly-shaped end surfaces of a non-linear optical crystal element generating second harmonic light and from document D4 (cf. Figure 1) which shows the provision of a reflective surface on the back end of the laser medium of a second harmonic generator.

3.5 However, applying to the second harmonic generator known from D1 even the combined suggestions given in documents D2 to D4 as to the integration of optical components would not have led the skilled person to the

claimed resonator structure.

In a first straightforward step of integration of the optical components of the second harmonic generator as known from D1, the skilled person would have laminated together the quarter-wavelength plate, the non-linear optical crystal element and the laser medium in the known order so as to form a monolithic body. Moreover, it would have been a straightforward measure to integrate the concave back end mirror shown in Figure 1 of D1 in the form of a reflective coating on a convexly-shaped back-end surface of the laser medium.

As regards the provision of the output mirror at the front end of the resonator, however, the most obvious alternatives the skilled person would have contemplated would have been either to adopt the example of D2 and to adhere the concave output mirror known from D1 by means of an adhesive to the free end surface of the quarter-wavelength plate, or to refrain from the integration of this mirror altogether as it was apparently impossible to provide the required curved surface for a reflective coating on the thin quarter-wavelength plate.

3.6 No further step of integration was possible with the arrangement of the optical components according to D1.

Thus, to arrive at the claimed subject-matter would have presupposed the recognition of two, at first glance unrelated facts, namely that the concave output mirror could be integrated as a reflective coating, if the output end of the monolithic body was constituted by a sufficiently thick optical element and that the order of the optical components in the second harmonic

generator of D1 could be interchanged without interfering with their optical functions.

Although it could be argued that the skilled person theoretically **could** have realised these facts, there is no reason to assume, in the absence of any indication in the available prior art as to an alternative arrangement of the optical components of an output-stabilized second harmonic generator and the circumstances of their structural integration, that he **would** have purposefully combined the results of such considerations in order to still further increase the degree of structural integration.

3.7 For the foregoing reasons, in the Board's judgement, the subject-matter of claim 1 on file involves an inventive step within the meaning of Article 56 EPC. Claim 1 therefore complies with the requirements of Article 52(1) EPC.

3.8 Dependent claim 2 relates to a non-trivial embodiment of the second harmonic generator and complies with the requirements of Article 52(1) EPC as well.

4. The Board is satisfied that the amended description too meets the requirements of the EPC.

Order

For these reasons it is decided that:

1. The decision of the Examining Division is set aside.

2. The case is remitted to the Examining Division with the order to grant a patent on the basis of the documents indicated in point VI above.

The Registrar The Chairman

R. Schumacher G. Davies