

Veröffentlichung im Amtsblatt	Ja/Nein
Publication in the Official Journal	Yes/No
Publication au Journal Officiel	Oui/Non

Aktenzeichen / Case Number / N^o du recours : T 567/89 - 3.4.2

Anmeldenummer / Filing No / N^o de la demande : 85 903 153.6

Veröffentlichungs-Nr. / Publication No / N^o de la publication : WO 86/00 427

Bezeichnung der Erfindung: Deep U.V. lithography

Title of invention:

Titre de l'invention :

Klassifikation / Classification / Classement : G03F 7/20, G02B 27/00

ENTSCHEIDUNG / DECISION

vom / of / du 17 September 1990

Anmelder / Applicant / Demandeur : American Telephone & Telegraph Company

Patentinhaber / Proprietor of the patent /

Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56 EPC

Schlagwort / Keyword / Mot clé : "Inventive step - yes"

Leitsatz / Headnote / Sommaire



Case Number : T 567/89

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 17 September 1990

Appellant : AMERICAN TELEPHONE & TELEGRAPH COMPANY
550 Madison Avenue
New York
NY 10022 (US)

Representative : Johnston, Kenneth Graham
AT & T (UK) LTD.
AT & T Intellectual Property Division
5 Mornington Road
Woodford Green
Essex, IG8 0TU (GB)

Decision under appeal : Decision of Examining Division 043
of the European Patent Office
dated 4 April 1989 refusing European
patent application No. 85 903 153.6
pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : J. Roscoe
Members : W. Hofmann
L. Mancini

Summary of Facts and Submissions

- I. European patent application No. 85 903 153.6 (international publication No. WO 86/00 427) was refused by decision of the Examining Division.
- II. The reason for the refusal as given by the Examining Division was that no inventive step in the sense of Article 56 EPC could be seen in narrowing the wavelength of a laser to such extent that a lens assembly made of a single optical material would not cause chromatic aberration since, in particular, a great number of opto-electrical devices, e.g. all well known CD-players, already used the same principle.
- III. The Appellant lodged an appeal against the decision.
- IV. Following a communication pursuant to Article 110(2) EPC in which the rapporteur on behalf of the Board objected to the non-compliance of the then valid claims with the requirements of Articles 84 and 123(2) EPC, the Appellant finally requested that the decision under appeal be set aside and a patent be granted on the basis of Claims 1 to 10 as filed on 6 July 1990, of which Claims 1 and 8, the only independent claims, read as follows:

"1. A deep U.V. lithography system comprising a laser (12) which inherently emits relatively wide bandwidth electromagnetic radiation, and a lens assembly (108) in optical communication with said laser, said lens assembly exhibiting acceptably low chromatic aberration to the laser radiation impinged upon the assembly, CHARACTERISED IN THAT the lens assembly is made of fused silica, which fused silica would inherently exhibit unacceptably high chromatic aberration to the relatively wide bandwidth radiation inherently emitted by said laser, and in that

means (54) are provided for sufficiently narrowing the bandwidth of the radiation emanating from said laser and impinging upon the fused silica so as to achieve acceptably low chromatic aberration.

8. A method of achieving acceptably low chromatic aberration of laser radiation transmitted via a lens assembly in an optical lithography system, the laser inherently emitting relatively wide bandwidth electromagnetic radiation, CHARACTERISED IN THAT the lens assembly is made of fused silica which would inherently exhibit unacceptably high chromatic aberration to the relatively wide bandwidth radiation inherently emitted by the laser, and in that the method further comprises narrowing the bandwidth of the radiation emanating from the laser and impinging upon the lens assembly to a sufficient extent so as to achieve acceptably low chromatic aberration."

The remaining Claims 2 to 7 and 9 to 10 are respectively appended to independent Claims 1 and 8.

V. Appellant's arguments in favour of the acceptability of his request, which he supported by a number of documents attached to his Statement of Grounds of Appeal of 1 August 1989 and to his letter dated 2 July 1990, can be summarised as follows:

(a) The desirability of using shorter and shorter wavelengths in lithography to obtain high resolution has been known for many years and has led to the use of deep U.V. lithography. Prior to 1982 the sources of deep U.V were of relatively low power making it essential for each exposure of a resist to take several minutes, which of course was totally impractical.

In March 1982 it was proposed that deep U.V. excimer lasers could be employed for deep U.V. lithography and that started vigorous research into that area, because such lasers had far greater power than any previously suggested lasers.

The use of higher powered excimer lasers introduced advantages to lithography, such as increased speed of operation. On the other hand, the use of such lasers also introduced several disadvantages. In particular, an excimer laser, such as a KrF excimer laser, exhibits a bandwidth of 3.2\AA , which is three hundred times the bandwidth exhibited by a "classical" laser (0.01\AA), such as a He-Ne laser. This relatively large bandwidth caused chromatic aberration problems which obviously would cause the resolution to deteriorate, and it was proposed that these problems be solved entirely by the use of multicomponent lens assemblies. However, when deep UV systems employing multicomponent lens assemblies were actually built, it was found that they were only capable of imaging a field which was about $5\text{ mm} \times 5\text{ mm}$ (see enclosure 4 accompanying the Statement of Grounds), which is equivalent to a circular field of about 7 mm in diameter, whereas the industry required a field size of at least $15\text{ mm} \times 15\text{ mm}$ which is equivalent to a circular field of about 20 mm in diameter.

In contrast, whilst it was clearly well appreciated at the date of the invention both that truly monochromatic light could be refracted by a lens of single material without there being chromatic aberration, and that the bandwidths of laser outputs could be reduced, the inventor was the first to realise that if the need to eliminate chromatic aberrations in deep U.V. laser lithography is removed

by employing a line-narrowed excimer laser, then it becomes much easier to design and build a lens assembly capable of imaging a relatively large field, e.g. a field having a diameter of 20 mm. He also recognised that fused silica would be an ideal material for the lens assembly because it is stable at deep U.V. wavelengths and readily polished to produce high quality optical lenses. These realisations led to the claimed system, which not only achieves a relatively large field size, but also achieves very high resolution and permits electronic focus tracking.

- (b) With respect to the objection raised by the rapporteur in his communication to the absence from the independent claims of an indication that the lithography system also comprises a scanning mirror assembly to overcome any interference effect caused by the use of narrow bandwidth laser radiation, it should be noticed that commercial systems using narrowed bandwidth excimer lasers and fused silica lens with no scanning mirror actually perform in a satisfactory manner.

Moreover, in applications where such interference effects are of concern, there are ways of minimising them other than by using a scanning mirror, such as for example by placing a diffuser, preferably a rotating diffuser at the entrance of the condenser of the optical system.

Accordingly, the presence of a scanning mirror assembly is not an essential feature of the invention and it need not, therefore, be recited in the claims.

Reasons for the Decision

1. The appeal is admissible.
2. The present application documents meet the formal requirements of the EPC.

In particular, the features of independent Claims 1 and 8 and their intended purpose as recited in the claims are disclosed, inter alia, on page 4, lines 20 to 31 of the application documents as originally filed, and the amendments brought to the description, including those made ex officio by the Board for correcting obvious errors (page 1 as filed on 17 January 1989, line 27: "Claim 9" corrected to "Claim 8"; page 4 as filed on 17 January 1989, line 4: "comprising" corrected to "made of") only bring the statements of invention of the description into conformity with the current version of the claims.

Moreover, the Board sees no reason to question Appellant's submission that deep U.V. lithography systems comprising narrowed bandwidth excimer lasers and fused silica lens only with no scanning mirror might actually produce satisfactory results (see point V(b) above). Accordingly, the absence from the independent claims of any feature relating to the provision of a scanning mirror assembly as disclosed in the description does not result in these claims failing to be supported by the description as required under Article 84 EPC.

3. Novelty

The document EP-A-0 066 053 discloses a deep U.V. lithography system as defined also in the preamble of present independent Claim 1, comprising a laser, for instance a pulsed KrF gas excimer laser (Claims 1 and 2) as

used also in the specific embodiments disclosed in the present application, which therefore also inherently emits relatively wide bandwidth electromagnetic radiation in the sense of present Claim 1, and a lens assembly (page 6, lines 10 to 12: "refractive optical elements" of the projection lithographic system) in optical communication with said laser, said lens assembly exhibiting acceptably low chromatic aberration to the laser radiation impinged upon the assembly (page 6, lines 12 to 16: chromatic aberrations are corrected).

In this known system, the lens assembly is made of a limited number of transparent optical materials with different refractive indices (page 6, lines 12 to 16) and no means are provided for narrowing the bandwidth of the radiation emanating from the laser before impinging upon the lens assembly.

Thus, the subject-matter of independent Claim 1 is distinguished from that known deep U.V. lithography system in that the lens assembly is made of fused silica only, which fused silica would inherently exhibit unacceptably high chromatic aberration to a relatively wide bandwidth radiation inherently emitted by the laser, and in that means are provided for sufficiently narrowing the bandwidth of the radiation emanating from the laser and impinging upon the fused silica so as to achieve acceptably low chromatic aberration, as set out in the characterising portion of the claim.

The other documents on file do not come closer to the subject-matter of independent Claim 1. In particular, none of them discloses a deep U.V. lithography system comprising in combination a bandwidth narrowed laser source with a lens assembly made of a single material.

For these reasons, the subject-matter of independent Claim 1 is novel in the sense of Article 54 EPC.

4. Inventive step

- 4.1 Starting from the nearest prior art system as disclosed in document EP-A-0 066 053 and defined in the preamble of independent Claim 1, the technical problem to which the characterising features of the claim afford a solution is essentially to allow the realisation of a superior lens design (page 4, lines 31 to 35), since in particular it becomes much easier to design and build a lens assembly capable of imaging a relatively large field when a single optical material is used for the lens (see point V(a) above).

This technical problem is solved essentially in that the lens assembly is made only of fused silica and in that the chromatic aberrations which would normally occur if such lens assembly were used with the known laser radiation source are avoided by adequately narrowing the bandwidth of the radiation.

- 4.2 Indeed, it is undisputably common general knowledge that chromatic aberrations produced by a lens assembly on an optical radiation are minimised when the radiation exhibits reduced bandwidth. However, the Board is not satisfied that the skilled person striving to improve known deep U.V. lithography systems could, without hindsight, be expected to envisage applying this general knowledge also in this very specific context and, consequently, to contemplate reducing the bandwidth of the known deep U.V. laser sources.

On the contrary, the prior art documents on file show that the natural property of deep U.V. laser sources to emit laser radiation of relatively wide bandwidth and poor coherence, as compared with other laser sources, was, at the claimed priority date, generally recognised as an essential advantage of these laser sources when used in photolithography, since it avoided the formation of adverse speckle patterns and other interference effects produced by highly coherent radiation impinging on irradiated objects.

Attention is drawn in this respect to the documents EP-A-0 066 053 (page 9, last paragraph) and 8179 IEEE Electron Devices Letters, Vol. EDL-3, March 1982, No. 3 (page 53, right-hand column, second paragraph and page 54, left-hand column, lines 9 to 12) cited in the International Search Report, to the document Microcircuit Engineering Conference, October 1982 (page 16, right-hand column, fourth paragraph) referred to in Appellant's Statement of Grounds of Appeal and to the documents Solid state Technology, December 1983 (page 166, left-hand column, third paragraph), IEEE Electron Device Letters, Vol. EDL-5, No. 1, January 1984 (page 24, last but two sentence) and Applied Optics, Vol. 23, No. 5, 1 March 1984 (page 648, left-hand column, penultimate sentence) referred to in the present description.

The so clear and consistent emphasis put in the prior art on the naturally wide bandwidth and related properties of short coherence length and poor spatial coherence of the laser radiation, in the Board's opinion, adequately demonstrates the existence of a technical prejudice for the skilled person against narrowing the bandwidth of the laser radiation in the known deep U.V. lithography system.

In view of this technical prejudice, and in the absence, furthermore, of any teaching that the problem of speckle formation under laser illumination might be overcome in any other manner than by selecting a broad bandwidth laser source, the idea of narrowing the bandwidth of the radiation emanating from a deep U.V. laser source in a lithography system cannot be considered to be derivable in an obvious manner from the known prior art and the subject-matter of independent Claim 1, therefore, involves an inventive step in the sense of Article 56 EPC.

5. For the above reasons, the subject-matter of independent Claim 1 is patentable (Article 52 EPC). So is the subject-matter of independent Claim 8 which comprises substantially the same limitations as said independent Claim 1, in terms of method features. The subject-matter of dependent Claims 2 to 7 and 9 and 10 is also patentable by virtue of their dependency on independent Claims 1 and 8, respectively.

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 with the order to grant a patent on the basis of the following documents:

description: pages 1 and 4 as filed on 17 January 1989, after correction of the following obvious errors: on page 1, line 27, "Claim 9" is replaced by "Claim 8" and on page 4, line 4, "comprising" is replaced by "made of"; and pages 2, 3 and 5 to 15 as originally filed;

claims: 1 to 10 as filed on 6 July 1990;

drawings: pages 1/3 to 3/3 as originally filed.

The Registrar:

The Chairman

P. Martorana

J. Roscoe