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

Case Number: T 0093/05 - 3.4.03

Application Number: 99112835.6

Publication Number: 0969494

IPC: H01J 37/02

Language of the proceedings: EN

Title of invention:
Apparatus and method for examining specimen with a charged particle beam

Applicant:
ICT Integrated Circuit Testing

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56, 83

Keyword:
"Main, first to third auxiliary requests: inventive step (no)"
"Fourth auxiliary requests: sufficiency of disclosure (no)"

Decisions cited:
-

Catchword:
-

Case Number: T 0093/05 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 30 June 2006

Appellant: ICT Integrated Circuit Testing
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 7 September 2004 refusing European application No. 99112835.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. Eliasson
Members: V. L. P. Frank
T. Bokor

Summary of Facts and Submissions

I. This is an appeal from the refusal of European patent application 99 112 835.6 for lack of novelty and of inventive step (Article 54 and 56 EPC).

II. The following prior art documents *inter alia* were cited in the examination procedure:

D5: DE 33 32 248 A

D6: US 5 591 970 A

A copy of document D8: "The principles and practice of electron microscopy" by I. M. Watt, 1989, pages 21 and 41 to 43, was attached to a communication of the board.

III. At the oral proceedings before the board the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the main or the 1st to 4th auxiliary requests filed with the letter of 30 May 2006.

IV. Independent claim 1 of the main request is worded as follows:

"1. An apparatus for examining a specimen with a beam of charged particles comprising:
a particle source (18) for providing a beam of charged particles;
an optical device for directing said beam of charged particles onto said specimen to be examined;
a gas supply (14) for providing an inert gas to the area of incidence of said beam of charged particles

onto said specimen, said gas supply comprises a gas conduit with an outlet opening of the gas conduit with a diameter of about 100 µm;
a vacuum chamber (26) for loading said specimen; and
an aperture (23) separating an optical column from the vacuum chamber (26),
wherein the gas conduit is provided in form of a tube and the outlet opening is directed towards the area of incidence of the beam of charged particles."

Independent claim 1 of the 1st auxiliary request is worded as follows:

"1. An apparatus for examining a specimen with a beam of charged particles comprising:
a particle source (18) for providing a beam of charged particles;
an optical device for directing said beam of charged particles onto said specimen to be examined;
a gas supply (14) for providing an inert gas to the area of incidence of said beam of charged particles onto said specimen;
a vacuum chamber (26) for loading said specimen; and
an aperture (23) separating an optical column from the vacuum chamber (26),
wherein the gas supply comprises two or more nozzles for providing the inert gas."

Independent claim 1 of the 2nd auxiliary request is worded as follows:

"1. A method for examining a specimen using a charged particle beam comprising the following steps:
a. loading said specimen in a vacuum chamber;

b. directing said charged particle beam through an aperture separating an optical column from a vacuum chamber to a desired position of said specimen to be examined; and
c. providing a stream of inert gas to said desired position from an outlet opening of a gas conduit, the stream of inert gas being directed towards the area of incidence of the beam of charged particles."

Independent claim 1 of the 3rd auxiliary request is worded as follows:

"1. An apparatus for examining a specimen with a beam of charged particles comprising:
a particle source (18) for providing a beam of charged particles;
an optical device for directing said beam of charged particles onto said specimen to be examined;
a gas supply (14) for providing an inert gas to the area of incidence of said beam of charged particles onto said specimen;
a vacuum chamber (26) for loading said specimen; and
an aperture (23) separating an optical column from the vacuum chamber (26),
wherein the gas supply comprises two or more nozzles to provide the inert gas, and wherein the two or more nozzles are arranged in a symmetrical pattern, the location of the incident primary electron beam being the center of symmetry."

Independent claim 1 of the 4th auxiliary request is worded as follows:

"1. An apparatus for examining a specimen with a beam of charged particles comprising:
a particle source (18) for providing a beam of charged particles;
an optical device for directing said beam of charged particles onto said specimen to be examined;
a gas supply (14) for providing an inert gas to the area of incidence of said beam of charged particles onto said specimen;
a vacuum chamber (26) for loading said specimen; and
an aperture (23) separating an optical column from the vacuum chamber (26),
wherein the gas supply includes a gas conduit integrated in an objective lens or in an electrode of an electrostatic lens."

V. The appellant argued essentially as follows:

- Although document D5, which is the closest prior art, disclosed an apparatus which could be used in a scanning electron microscope (SEM) for providing a flow of gas onto the specimen to remove the surface charges which accumulate on the surface of non conducting specimens, it did not disclose an aperture, but an "exit window", separating the optical column from the vacuum chamber in which the specimen was located. Not every opening was an aperture. Instead, an aperture in a particle beam device, such as a SEM, either limited the quantity of charged particles or, as a pressure limiting aperture, had a noticeable effect on a gas flow resistance.

- Document D5 originally started from a working system and then inserted gas. Thus, for a skilled person, the objective technical problem was to cope with the additional gas or to eliminate the disadvantages introduced by the gas. The solution found in D5 was to evacuate the chamber with the funnel 11. It therefore lead away from the solution of claim 1, namely to provide an aperture between the optical column and the vacuum chamber. The aperture limited the amount of gas that might enter the optical column.

- Claim 1 according to the 1st and 3rd auxiliary requests comprised more than one nozzle and provided the opportunity to increase the rotational symmetry around the area of incidence of the primary electron beam. This reduced the negative influence on the electrical and magnetic fields that a conductive or magnetic gas conduit might have.

- The integration of the gas conduit into the objective lens according to the 4th auxiliary request was neither taught nor suggested by any prior art reference and reduced still more the negative influence of the gas conduit on the beam of charged particles.

Reasons for the Decision

1. The appeal is admissible.

2. The application addresses the problem of image distortion encountered when a nonconducting specimen is

being examined eg in a scanning electron microscope (SEM). Some of the primary electrons of the beam accumulate on the specimen and can give rise to a strong electric field which may distort the image. In the past, a variety of methods have been tried to solve this problem. The approaches included adaptation of the acceleration voltage and the current of the electron beam, or coating the sample with a conducting layer. However, all these solutions have some drawbacks ([0006] to [0008] of the published application). The solution proposed in the present application consists essentially in directing a stream of gas to the area where the electron beam hits the specimen and which removes the charges accumulated in the specimen (ibid abstract).

3. Document D5 discloses a system that can easily be adapted to any conventional SEM for reducing the charging of non conducting specimens and the related problem of image distortion (abstract). A flow of gas 1 is directed through a nozzle 10 onto the area of the specimen 5 which is being imaged. The gas is removed from the vacuum chamber through an opening 11 (pages 3 and 4; Figures 1 and 2).

4. *Main request*

4.1 The appellant applicant argued that in the apparatus of claim 1 the optical column was separated from the vacuum chamber by an aperture 23. Such an aperture limited the size of the beam and had dimensions of the same order of magnitude as the beam. The aperture as specified in claim 1 also had noticeable effect on the gas flow allowing the column to be at a higher vacuum than the vacuum chamber where the specimen was placed. In contrast, document D5 disclosed merely an opening at the top of the vacuum chamber through which the electron beam entered the chamber (Figures 1 and 2). An opening of the kind disclosed in document D5 was much larger and neither impeded the gas flow between the chamber and the optical column nor limited the beam of charged particles.

4.2 The board is not persuaded by this argument. Firstly, it is shown in Figure 1 of D5 that the electron beam has the same size as the opening at the top of the figure. This opening is therefore an aperture in the sense of the present application as it is of the same order of magnitude as the beam. Secondly, document D8, which is a handbook on electron microscopy, discloses that a beam-limiting diaphragm is generally provided after the final condenser lens, defining thus the depth of focus of the microscope (page 42, 3rd paragraph, Figure 2.25). This diaphragm is therefore also an aperture in the sense of the application. Hence, as the system disclosed in document D5 is easily incorporated in any conventional SEM (D5, abstract), any actual electron microscope incorporating the charge removal system of D5 comprises also a beam limiting aperture.

4.3 The apparatus of claim 1 therefore differs from that of document D5 only in that the outlet opening of the gas conduit has a diameter of about 100 µm, since the feature that the gas supply provides an inert gas to the area of incidence of the beam of charged particles is interpreted in a device claim as merely meaning that the gas system is suitable for this purpose and since the gas conduit disclosed in document D5 fulfills this requirement.

4.4 Document D5 does not disclose the size of the gas conduit. However, the appellant applicant has not argued that this size has a technical effect other than the one of defining the gas flow impedance. Nor is any other special technical effect disclosed in the application. The board therefore concludes that the selection of the size of this opening is made by the skilled person having regard to the particular circumstances.

4.5 For these reasons, the apparatus of claim 1 does not involve an inventive step in the sense of Article 56 EPC.

5. *1st Auxiliary request*

5.1 The apparatus according to claim 1 of this request includes the further feature of a multitude of nozzles for providing the inert gas.

5.2 As the location of the nozzles or their specific form is not specified in the claim, the technical problem addressed by this feature is to allow the supply of larger amounts of gas than in the apparatus of D5.

5.3 However, a standard measure for achieving this effect is to increase either the number or the cross section of the gas conduits. Selecting one of these alternatives is to be considered obvious to the skilled person.

5.4 The apparatus of claim 1 does therefore not involve an inventive step.

6. *2nd Auxiliary request*

6.1 Claim 1 of this request is directed to a method for examining a specimen using essentially the apparatus of claim 1 of the main request.

6.2 Although claim 1 of the main request already requires that a stream of an **inert** gas is blown onto the specimen, this requirement is interpreted in a device claim as merely meaning that the gas system is suitable for supplying such kind of gases. However, in a method claim the same feature implies that an inert gas is actually supplied.

6.3 Although document D5 is silent on the kind of gas used for removing the charges from the specimen, it follows from the purpose for providing the gas that any reaction between gas and specimen other than the removal of charges is not intended. However, a gas that does not react with the specimen is an inert gas within the meaning of the present application. The skilled person would therefore consider using only inert gases when using the apparatus of document D5 in a conventional SEM.

6.4 The method of claim 1 of this request does therefore not involve an inventive step.

7. *3rd Auxiliary request*

7.1 The apparatus of claim 1 of this request requires in addition to the apparatus of claim 1 of the 1st auxiliary request that the gas nozzles be arranged in a symmetrical pattern around the center of symmetry defined by the incident beam.

7.2 The gas which is introduced into the vacuum chamber for removing the charges from the specimen worsens the degree of vacuum within the chamber and may even have a negative influence on the vacuum within the optical column. To reduce this negative influence, the gas conduits have to deliver the inert gas as close as possible to the area of the specimen where the charging takes place. This is, however, the area where the electron beam impinges on the specimen. Any metallic or magnetic object located in this area has an influence on the electromagnetic field of the beam (see eg document D6, column 1, line 64 to column 2, line 17 where the effect of a nozzle on the potential distribution is discussed). The skilled person would always seek to reduce this influence as much as possible in order to avoid distortion of the generated image and would therefore provide the gas nozzles in a symmetric arrangement around the location where the beam strikes the specimen.

7.3 The apparatus of claim 1 therefore does also not involve an inventive step.

8. *4th Auxiliary request*

8.1 In the apparatus of claim 1 of this request the gas supply includes a gas conduit which is integrated in an objective lens or in an electrode of an electrostatic lens. This embodiment is illustrated in Figures 8 and 9 of the application which show the gas conduit 32 traversing the body of the lens 30 and ending either at the inner bore or at the lower end of the electrostatic or magnetic lens (column 12, line 44 to column 13, line 1).

8.2 The gas is therefore supplied in the claimed apparatus through a gas conduit located in a lens which is part of the optical column. As discussed above, the appellant applicant argued with respect to the main request that the aperture separates the optical column from the vacuum chamber in which the specimen is located for allowing differential pumping between both regions (see also Figure 3 of the application). It is, however, not disclosed in the application how under these circumstances the gas may traverse the aperture and reach the specimen and how it removes the charges which accumulate on the specimen. On the contrary, the gas is supplied into the bore of the optical column which has to be kept at a very high degree of vacuum in order not to perturb the path of the charged particles (D8, page 21, right hand column). In other words, the gas is introduced in a region of the apparatus where it would prevent a proper functioning of the apparatus.

8.3 The above is also true even in the case where the gas conduit ends at the lower end of the lens 30, since also in this case the aperture would be located between the outlet opening of the gas conduit and the specimen (see Figure 3).

8.4 For these reasons, it is the judgment of the board that the invention according to this request is not disclosed in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art (Article 83 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

Registrar Chair

S. Sánchez Chiquero G. Eliasson