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**Datasheet for the decision
of 5 July 2016**

Case Number: T 1123/10 - 3.4.03

Application Number: 03077738.7

Publication Number: 1394834

IPC: H01J37/305, G01N1/32, G01N1/42,
H01J37/28, H01J37/02

Language of the proceedings: EN

Title of invention:

Method of obtaining an image of a sample in a particle-optical device

Patent Proprietor:

FEI COMPANY

Opponent:

Carl Zeiss Microscopy GmbH

Headword:

Relevant legal provisions:

EPC 1973 Art. 54, 56, 100(a)
EPC Art. 52(1)
RPBA Art. 13(1)

Keyword:

Novelty - (yes)

Inventive step - (yes)

Decisions cited:

Catchword:



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Case Number: T 1123/10 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 5 July 2016

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Decision under appeal: **Decision of the Opposition Division of the
European Patent Office posted on 8 March 2010
rejecting the opposition filed against European
patent No. 1394834 pursuant to Article 101(2)
EPC.**

Composition of the Board:

Chairman G. Eliasson
Members: S. Ward
T. Bokor

Summary of Facts and Submissions

- I. This is an appeal by the opponent against the decision of the Opposition Division rejecting the opposition against European patent EP 1 394 834.
- II. The opposition had been filed against the patent in its entirety. Grounds for the opposition were lack of novelty and lack of inventive step (Articles 100(a), 52(1), 54 and 56 EPC).
- III. At the end of the oral proceedings held before the Board the appellant-opponent (hereinafter, the opponent) requested that the decision under appeal be set aside and that the patent be revoked; the respondent-proprietor (hereinafter, the proprietor) requested that the appeal be dismissed.
- IV. The following documents are cited in this decision:
- E1: T Colliver et al: Atomic and molecular imaging at the single-cell level with TOP-SIMS; Analytical Chemistry, Volume 69, Number 13, 1 July 1997, pages 2225-2231
- E3: US 5 093 572
- E10: J Gierak et al: 3D Defect distribution induced by focused ion beam irradiation at variable temperatures in a GaAs/GaAlAs multi quantum well structure; Microelectronic Engineering, volume 30, 1996, pages 253-256
- E11: K M Mayer et al: Imaging of self-generated multifilamentary current

patterns in GaAs; Z. Phys. B - Condensed Matter, Volume 71, 1988, pages 171-178

E12: R Gross et al: Low temperature scanning electron microscopy of superconducting thin films and Josephson junctions; Reports on Progress in Physics, Volume 57, 1994, pages 651-741.

V. Claim 1, using the feature labelling employed by both parties, reads as follows:

"Method for obtaining a particle-optical image of a sample in a particle-optical device, in which

a) the sample (18), which has been put in a frozen state, is subjected to a vacuum environment (6), and

b) the particle-optical image of at least a portion of the sample is made with the aid of a scanning focused electron beam (24),

characterized in that,

c) a cooled opposing surface (10) has been provided, said cooled opposing surface opposing the sample (18),

d) said sample (18) being at a temperature higher than that of the opposing surface (10),

e) and that, after that the sample (18) is subjected to the vacuum environment (6), images are taken while, successively:

e1) the sample (18) is subjected to a milling operation using an ion beam (20), said milling operation causing

a pre-selected cross-section (32) of the sample (18) to be exposed, and

e2) the temperature difference between the sample (18) and the cooled opposing surface (10) is increased, which increase of the temperature difference leads to sublimation of the exposed cross-section of the sample,

f) the image of at least a portion of the sample (18) is the image of at least a portion of an exposed cross-section of the sample."

VI. The opponent's arguments, insofar as they are relevant to the present decision, may be summarised as follows:

The Opposition Division accepted that features a), d), e), and f) were disclosed in document E1. Furthermore, the Opposition Division recognised that the cold knife of document E1 is a cooled opposing surface in the sense of claim 1.

Claim 1 did not require either that the cooled opposing surface be located in the imaging chamber or that the sublimation step be carried out in the imaging chamber. Moreover, the steps e1) and e2) did not necessarily have to take place simultaneously with, or in the same chamber as, the imaging process. The word "opposing" did not have any implications for the spatial location of the surface, but only referred to its functional role as described in paragraph [0008]. Hence, features c) and e2) were disclosed in document E1.

In relation to feature b), the Opposition Division recognised that document E1 disclosed a pulsed electron beam but found no disclosure that this beam was focused or scanned. Claim 1 did not state to what extent the

electron beam was supposed to be focused. The same was true for scanning: there was no indication in either claim 1, or in the arguments of the Opposition Division, which characteristics an electron beam should have in order to be seen as a scanning electron beam in the sense of the opposed patent.

Contrary to the view of the Opposition Division, ion currents considerably below 1 nA allowed material removal in the sense of the claimed milling. Since claim 1 did not specify any particular ion current or any processing time or rate, the ion current disclosed in E1 (60 to 500 pA) would certainly be suitable to carry out the claimed milling. Moreover, claim 1 did not exclude that, during the ion irradiation, interaction products could be detected and subsequently used for imaging. Hence feature e1) was disclosed in document E1.

All claimed features could therefore be found in document E1 - at least given the broad manner in which claim 1 was formulated - and hence the claimed subject-matter lacked novelty.

Even if it were accepted that the pulsed electron beam of document E1 was not disclosed as being focused or scanned, the subject-matter of claim 1 would not involve an inventive step. It would be natural to use an electron beam corresponding to the dimensions of the ion beam (hence, focused) and corresponding to the movement of the ion beam (hence, scanned). In any event, there were only two possibilities for the charge compensation electron beam: either defocused and covering the entire imaging region, or focused and scanned over the region. Choosing between two known possibilities did not involve an inventive step.

The subject-matter of claim 1 was also obvious starting from document E3 as closest prior art and combining with document E1. Claim 1 differed in the cryo-aspects: the sample was put in a frozen state, a cooled opposing surface was provided, the sample was held at a higher temperature than the opposing surface, and the temperature difference between the sample and the opposing surface was raised to achieve sublimation.

The problem to be solved was to make the technique for observing different cross-sections disclosed in E3 also available for biological samples, which are often prepared by freezing. Having exposed a desired cross-section by ion beam, the skilled person would inevitably observe that the image would be dominated by ice crystals. Document E1 disclosed a solution to overcome this, namely providing a cooled surface or cold trap, and temporarily raising the temperature difference between the sample and the cold trap to sublimate the ice from the surface of the sample. Clearly this cold trap must be arranged close to the sample in the sample chamber of the electron microscope. In this way the skilled person would be led to all features of claim 1 of the opposed patent.

The use of cryo-methods in electron microscopy was not limited to biological samples; it was also known to form images of semiconductor devices at low temperatures (documents E10-E12).

VII. The proprietor's arguments, insofar as they are relevant to the present decision, may be summarised as follows:

The purpose of the electron beam was to make an image of at least a portion of the sample (as specified in claim 1), and the skilled person was provided with enough information to configure and arrange a scanning focused electron beam to make an appropriate image, contrary to the appellant's assertion that the terms "focused" and "scanning" in relation to the electron beam are not defined in the patent.

It would not be obvious for the skilled person to modify the electron beam of E1 by replacing the flood exposure with a scanned focused beam, and these were not the only two options to counteract charging. The appellant further failed to point out the motivation for a skilled person to modify a beam configured to provide charge compensation to a beam configured to image the sample.

The cold knife of document E1 could not be considered as the claimed cooled opposing surface, as "opposing" meant that the surface took up a position close enough to the sample to perform the sublimation step (e2) during imaging. The cold knife of E1 was comprised in a preparation (freeze-fracture) chamber, whereas imaging was performed in an imaging chamber.

E1 did not disclose an ion-beam used for milling (feature e1); the difference in beam current range confirmed the assertion that the ion-beam of E1 was used for imaging, not milling.

Document E3 could not be the closest prior art. It was directed towards a scanning electron microscope (SEM) comprising an ion milling beam for silicon wafers, and was completely unsuitable for milling biological

samples, nor was there any hint of its suitability for biological samples.

The documents E10-E12 were filed only with the letter of 2 June 2016, and did not in any event establish the common general knowledge in the art; these documents should not be admitted into the proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Admission of documents E10, E11 and E12*

The documents E10-E12 can be said to have been filed in response to issues which arose in the written procedure, and the Board therefore uses its discretion under Article 13(1) RPBA to admit them into the proceedings.

3. *Novelty in relation to document E1*

3.1 According to the feature labelling scheme set out above, feature (b) of claim 1 defines that:

- *"the particle-optical image of at least a portion of the sample is made with the aid of a scanning focused electron beam".*

3.2 The most natural and plausible reading of this feature is that the image is produced by the scanning focused electron beam. Accordingly, the phrase "with the aid of" is to be understood in the sense of "by" or "by means of", and this feature essentially defines that

the invention concerns scanning electron microscope (SEM) imaging.

- 3.3 Document E1 describes a method in which images are produced by TOF-SIMS (time-of-flight secondary ion mass spectrometry) which "utilizes a tightly focused primary ion beam to desorb chemical species from a solid matrix. Ejected ions are then collected and analysed using a mass spectrometer" (page 2225, first paragraph after abstract). The primary ions are gallium ions from a liquid metal ion gun, and an electron beam is provided for charge compensation of the sample (passage bridging pages 2227 and 2228). As the skilled person would be aware, charge compensation is a technique to prevent an undesirable build-up of positive charge on the sample due to the ion bombardment.

Document E1 therefore discloses ion-beam imaging, and not SEM imaging. If feature (b) is interpreted in the manner set out under point 3.2, above, this fact alone is sufficient to render the subject-matter of claim 1 novel over the disclosure of document E1.

- 3.4 An argument that document E1 anticipates the claimed subject-matter would therefore require *inter alia* that feature (b) be interpreted in the following sense:
- the claimed image may be produced by particles other than electrons; and
 - the phrase "with the aid of" may imply merely the provision of an ancillary electron beam not directly involved in imaging.

The argument would then be that the imaging particles could be identified with the gallium ions of document E1, and the claimed electron beam could be identified with the charge compensation electron beam in document E1 (although it would have to be further argued why

this beam should be considered to be "a scanning focused electron beam").

On the basis of the plain wording of feature (b), such an interpretation appears to the Board to be artificial and contrived. A minimum requirement for accepting such an interpretation would be that there should exist in the description of the opposed patent a clear indication that, within the context of the present invention, feature (b) is to be understood in this sense.

In fact, precisely the contrary is confirmed in the description, for example in paragraph [0009]: "This imaging occurs with the aid of a scanning focused electron beam (SEM imaging)".

- 3.5 Feature (b) therefore defines SEM imaging, and the claimed subject-matter differs from document E1 - which discloses only ion beam imaging - at least in this respect. It is therefore unnecessary for the Board to decide whether other differences exist.

A lack of novelty has not been alleged in relation to any other prior art, and the Board therefore concludes that the subject-matter of claim 1 is new within the meaning of Article 52(1) EPC and Article 54 EPC 1973.

4. *Inventive step starting from document E1*

- 4.1 In the light of the above, the Board judges that feature (b) alone is also sufficient to render the subject-matter of claim 1 inventive starting from document E1.

4.2 The opponent argues that if it is considered that document E1 does not disclose an electron beam which is focused and scanned, these would nevertheless be obvious choices. Even if, *arguendo*, this assertion were accepted, the fact remains that claim 1 defines a method in which an electron beam is used for imaging, whereas document E1 discloses a method in which an electron beam is used only for charge compensation.

The Board finds nothing in the submissions of the opponent which would explain convincingly how, starting from a method which is entirely focused on TOF-SIMS imaging, a skilled person would arrive via an obvious route at an SEM imaging method.

4.3 It is unnecessary for the Board to decide whether other inventive differences exist, since the above considerations are sufficient to establish that the subject-matter of claim 1 would not be obvious to the skilled person starting from document E1.

5. *Inventive step starting from document E3*

5.1 Document E3 discloses a scanning electron microscope for observing a cross-section of a portion of a semiconductor wafer, including an SEM column 100, and an FIB (focused ion beam) column 200 for cutting said cross section by scanning with an ion beam 31. A corresponding method is also disclosed (see e.g. claim 6).

5.2 The method of claim 1 differs from the method disclosed in document E3 at least in that:

- the sample has been put in a frozen state;
- a cooled opposing surface is provided;

- the sample is at a higher temperature than the opposing surface; and
- after ion milling the temperature difference is increased leading to sublimation of the exposed cross-section of the sample.

5.3 As explicitly confirmed in oral proceedings, the argument of the opponent in this respect is essentially that document E3, although disclosing a specific example concerning the inspection of semiconductor integrated circuits, relates generally to scanning electron microscopes and methods for observation of cross-sections employing such microscopes (column 1, lines 9-12). The skilled person would be aware that, apart from ancillary equipment, the same SEM may be used for both biological imaging and industrial inspection.

The opponent therefore contends that it would be obvious for the skilled person to use the SEM of document E3 to image biological specimens. Furthermore, rapid freezing to cryogenic temperatures is a well-known method of preparing such specimens ("cryo-SEM"), thus accounting for the first difference. The problem solved by the remaining differences (cooled opposing surface, temperature difference and increasing the temperature difference) is to remove unwanted molecules from the sample without disturbing it or breaking vacuum. The skilled person would easily arrive at these features in view of the cold trap arrangement of document E1 for removing surface water from the sample.

5.4 The Board notes that claim 1 of the opposed patent concerns a method for obtaining a particle-optical image of a sample. Document E3 discloses such a method, but only in the context of obtaining an SEM image of a

cross section of a semiconductor integrated circuit. No other type of sample is disclosed in document E3, nor is any purpose other than failure analysis and process evaluation of semiconductor integrated circuits envisaged.

5.5 The first distinguishing feature, concerning putting the sample "in a frozen state" is explained in paragraph [0007] of the opposed patent; this technique is routinely used for biological specimens such as the bacterium mentioned in paragraph [0004]. Putting the sample in a frozen state appears to make little sense in relation to semiconductor integrated circuits, and the Board is of the opinion that any argument that the skilled person would arrive at the claimed method from document E3 would have to involve switching to the imaging of samples for which cryo-SEM techniques would plausibly be used, in particular biological samples, as suggested by the opponent.

5.6 It must therefore be asked: what would motivate the skilled person to do this? More formally stated: what is the objective technical problem, the solution to which is to change the samples to be imaged from semiconductor integrated circuits to biological specimens? In the opinion of the Board, this could only be something like "to find a new use for the method of document E3", or "to apply the techniques of document E3 to a new technical field".

Such formulations do not represent realistic technical problems which would confront the skilled person, and can only be considered as artificial "problems" contrived to provide a route to the claimed subject-matter. It is not plausible that the skilled person would modify the closest prior art by entirely

abandoning the aim and purpose of the disclosed method - failure analysis and process evaluation of semiconductor integrated circuits - in favour of a completely different goal - the imaging of frozen biological samples.

- 5.7 Document E10 describes a study on irradiation of a multi quantum well structure with a Ga^+ focused ion beam (FIB), comparing the effects of irradiation at room temperature and near the liquid nitrogen temperature (80K) to determine whether low temperature FIB is advantageous. Document E11 describes SEM imaging of low temperature avalanche breakdown in GaAs. Document E12 describes low temperature SEM imaging of superconducting thin films and Josephson junctions.

These documents establish the unsurprising fact that cryo-SEM imaging may be used to investigate effects and processes which occur in semiconductor or superconductor devices at low temperatures. The Board does not, however, see why this should be considered to add anything relevant to the opponent's argument as summarised under point 5.3, above.

- 5.8 The arguments of the opponent in relation to obviousness are not found persuasive, and the Board judges that the subject-matter of claim 1 involves an inventive step within the meaning of Article 52(1) EPC and Article 56 EPC 1973.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated