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Datasheet for the decision of 12 January 2010

Case Number: T 1228/07 - 3.4.02

Application Number: 95943768.2

Publication Number: 0797763

IPC: G01N 21/88

Language of the proceedings: EN

Title of invention:
Scanning system for inspecting anomalies on surfaces

Applicant:
KLA-Tencor Corporation

Opponent:
-

Headword:
-

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 56

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

Decisions cited:
-

Catchword:
-

Case Number: T 1228/07 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 12 January 2010

Appellant:	KLA-Tencor Corporation 160 Rio Robles San Jose, CA 95134 (US)
Representative:	Luckhurst, Anthony Henry William Marks & Clerk LLP 90 Long Acre London WC2E 9RA (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted 1 February 2007 refusing European patent application No. 95943768.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

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

Summary of Facts and Submissions

I. The appellant has appealed against the decision of the examining division refusing European patent application number 95 943 768.2 on the ground that its subject-matter lacked an inventive step within the meaning of Article 56 EPC 1973 in view of the following documents:

D1: US489847
D2: US5027132
D3: EP0065051 (= US4376583)
D4: US4441124 (cited in D1)
PCT1: "Dual sensor technology for high-speed detection of 0.1 micron defects"; PROCEEDINGS OF THE SPIE, Vol. 1926, pages 570-581; 1993-00-00; ALUMOT D et al.

II. The appellant has requested that a patent be granted on the basis of claims filed with the statement of grounds for appeal.

The appellant's arguments can be summarised as follows:

The Examining Division refused this application on the basis that it was obvious to use the oblique illumination of D1 to replace the normal or near normal incidence optics in D2, to improve scanning speed.

However, the choice of normal versus oblique illumination in surface anomaly detection might depend on factors having nothing to do with scanning speed. Thus, it was widely recognised that particles scatter more light than pits or scratches when oblique illumination was used. Thus, when it was desirable to detect particles and discriminate against the detection of pits and scratches, it might be desirable to employ oblique illumination. On the other hand, where it was desirable to detect pits and scratches and discriminate against the detection of particles, it might be desirable to use normal illumination instead. In this connection reference was made to the article "Wafer Inspection Technology Challenges for ULSI Manufacturing", by Stokowski et al., Characterization and Metrology for ULSI Technology: 1998 International Conference.

Therefore factors such as the type of defect of interest for detection might be more important and might overshadow scanning speed.

The situation became more complicated when a pattern was present on the surface inspected, as in D1 and D2. As known to those skilled in the art, the pattern on semiconductor wafers was typically in the form of rectangular grids known as streets, and the grid pattern was known as Manhattan geometry. When a semiconductor wafer with a grid pattern was inspected by means of an illumination beam, the Manhattan geometry would diffract light from the beam. In order to obtain useful signal of the background in D2, the four detectors had to be placed at locations to avoid the detection of the diffracted light. Otherwise, the signal representing background might be overwhelmed by the diffraction at the detectors, so that the detector output became useless for measuring background.

When the grid pattern was illuminated with a beam at normal incidence, the pattern of diffraction would be in certain directions determined by the particular configuration of the grid pattern. However, if the beam at normal incidence was replaced by one at oblique incidence, the pattern of diffraction would be different from that caused by a beam at normal incidence. This meant that the detectors in D2 might have to be moved to locations that will avoid the detection of the pattern of diffraction caused by a beam at oblique incidence. There was no discussion in D2 as to where the detectors should be placed, aside from the need to avoid the detection of specularly reflected light. D2 contained no disclosure at all concerning the pattern of diffraction caused by the normal incident beam, and contained no disclosure on whether and where the detectors should be located to avoid the detection of the pattern of diffraction. In view of the complication of the shifting of the diffraction pattern described above, it might not occur to the skilled person to replace the illumination beam at normal incidence in D2 with one at oblique incidence. It was also not clear from D2 how the detectors had to be moved to avoid the detection of the position shifted diffraction pattern, even assuming one was to replace the normal incident beam by one at oblique incidence.

Thus, there was little or no reason why the skilled person would think of replacing or want to replace the normal or near normal incident beam of D2 by the oblique beam of D1.

The claims also required that the optical elements were arranged to detect forward scattered radiation. This was not taught or suggested by any one of the references. In D1 where the beam was at an angle within the range of 50° to 80° to the normal, only side scattered light at 90° in the azimuthal directions was detected.

The description in D1 was not clear as to the relative orientation of the oblique illumination beam and the rectangular grid pattern. Assuming the incidence plane of the oblique beam was parallel to one street direction of the rectangular grid pattern, there might be surface features such as lines that are at an angle to the street pattern, such as at 45°. In such instance, the diffraction of the 45° pattern would diffract light at 90° to the plane of the incidence of the beam, and might overwhelm any signal from anomalies reaching the detector.

When a 45° pattern feature was encountered with the system of the invention, the element or elements located to detect forward scattered radiation would then avoid the diffraction of the 45° pattern and would provide useful signal for anomaly detection. This feature resulted in a signal which was not masked by noise due to scattering from the pattern, and yielded superior detection performance compared to the systems in the references relied on in the decision of refusal.

D2 did not teach or suggest the detection of forward scattered light. D2 used normal illumination. The purpose of the disclosure in D2 was to detect background noise from background (such as epoxy board) separately from reflection from the pattern. D2 made no differentiation as to which one of the detectors actually detects the background, since the signals from all four detectors were added together before being provided to the photomultiplier tube. Since D2 employed normal illumination, all four detection channels would be symmetrically situated with respect to the illumination beam, so that forward scattering was not meaningful for D2.

From D1 the skilled man would be taught that the placement of detectors to detect at 90° in the azimuthal directions was adequate to minimize the detection of pattern scattered light.

References D3, D4 and PCT1 did not add anything of significance to D1 and D2 and were not relied upon in the decision.

The appellant disagrees with the Examining Division that the elements (a, b, c) of the previously-filed claims were simply an aggregate of unrelated elements without synergy. The combination of oblique illumination and the use of more than two detectors, each detecting scattering from a direction different from other detectors, was particularly advantageous. By using more than two detectors, the system had the flexibility to locate detectors where needed to avoid the diffraction pattern found on a wide variety of surfaces. In the invention defined by the replacement claims, where at least one of the detectors detected forward scattered radiation, the system was able to provide useful signals for anomaly detection even where a 45° oriented pattern was encountered, and this enhanced the functionality and performance of the system.

III. In an annex to the summons to oral proceedings requested by the appellant, the Board made preliminary non-binding comments with respect to novelty and inventive step of the claimed subject-matter. In the oral proceedings the applicant requested that a patent be granted on the basis of claims according to the main request or the auxiliary request filed on 12 December 2009. The independent claims of the main request read as follows:

"1. An optical system for detection of contaminant particles, pattern defects and surface imperfections as anomalies on a surface [40], comprising:

optics [22, 26, 34, 38] providing a beam [38] of radiation illuminating the surface at an oblique angle [θ] of between 50 and 80 degrees to the normal to the surface;

a plurality of detectors [110a, 110b, 111a, 111b]; a plurality of optical elements [110a, 110b, 111a, 111b] arranged to collect radiation scattered from the surface, including radiation scattered along the scan path in the forward direction azimuthally, each optical element being arranged to direct the collected, scattered radiation to a corresponding one of the detectors, causing the detectors to provide output signals in response thereto on independent collection channels, wherein the optical elements are located such that each of the detectors senses radiation scattered from the surface in a direction different from those of radiation sensed by the other said detectors;

a device comprising a moving stage [124] that causes relative motion between the beam and the surface; and

a processor [200] processing information from said detector output signals concerning radiation scattered from different parts of the surface in the multiple different directions from the detectors, and arranged to detect said anomalies;

said device further comprising an acousto-optic deflector [34], such that each of the moving stage and the acousto-optic deflector causes relative motion between the beam and the surface so that the beam scans a scan path covering substantially the entire surface, said path including a plurality of arrays of scan path segments [50, 50', 50'', 50'''], wherein at least some of such scan path segments have a span shorter than the dimensions of the surface [40], and so that the beam is caused to illuminate different parts of the surface such that the detectors provide output signals in response to radiation from different parts of the surface illuminated by the beam."

"23. An optical method for detection of contaminant particles, pattern defects and surface imperfections as anomalies on a surface [40], comprising:

illuminating the surface at an oblique angle [θ] of between 50° and 80° to the normal to the surface using a beam [38] of radiation;

collecting along independent collection channels radiation scattered from the surface including radiation scattered along the scan path in the forward direction azimuthally, and directing the collected, scattered radiation from each channel to a corresponding one of a number of detectors [110a, 110b, 111a, 111b], said numbers being greater than two causing the detectors to provide output signals in response thereto on the independent collection channels, said channels and detectors disposed so that each of the detectors senses radiation scattered from the surface in a direction different from those of radiation sensed by the other detectors; and at least one of the detectors is located to detect forward scattered radiation;

causing relative motion between the beam and the surface so that the beam scans a scan path on the surface, wherein said causing is by means of a moving stage [124]; and

processing information from said detector output signals concerning radiation scattered from different parts of the surface in the multiple different directions from the detectors, and using that information to detect the said anomalies;

the relative motion between the beam and the surface being caused by the moving stage and an acousto-optic deflector [34], such that the scan path covers substantially the entire surface, said path including a plurality of arrays of scan path segments [50, 50', 50'', 50'''], wherein at least some of such scan path segments have a span shorter than the dimensions of the surface, and so that the beam is caused to illuminate different parts of the surface such that the detectors provide output signals in response to radiation from different parts of the surface illuminated by the beam."

Reasons for the Decision

1. Amendments

1.1 Claim 1 according to the appellant's main request differs from the corresponding version underlying the impugned decision in that

(i) the oblique angle at which the radiation illuminates the surface is between 50° and 80° to the normal of the surface;

(ii) the radiation collected includes radiation scattered along the scan path in the forward direction azimuthally; and in that

(iii) there is a plurality of detectors.

Features i and ii are indicated in original claims 39 and 46, respectively. As to feature iii it is noted that the original independent claim 27 related to a system does not specify any specific number of detectors. However, in the description, page 14, lines 9 to 13 it is indicated that "detectors such as detector 111b collects light scattered by anomalies...". Thus the skilled person would derive that a plurality of detectors are employed in accordance with feature iii above.

1.2 Since there is no reason to question the finding of the examining division that the subject-matter of claim 1 underlying the impugned decision is originally disclosed, the Board concludes that this applies also to the present version of claim 1 including features i to iii. Similar reasoning applies to independent claim 23 related to a method. The dependent claims go back to original dependent clams. Therefore the Board reaches the conclusion that the amendments made are in accordance with Article 123 (2) EPC 1973.

2. Novelty and inventive step

2.1 The subject-matter of claim 1 according to the main request differs from what is disclosed in D2 by features defined in the impugned decision under point 6 ("NOVELTY") and referred to by the appellant in its statement of grounds for appeal, in particular by the oblique incidence of the beam of radiation. Moreover, D2 does also not disclose the above features i and ii.

2.2 The claimed subject-matter differs from the optical system described in D1, see Figure 1 with the associated description, by features ii and iii and by the feature related to short scans covering the surface. Since this document discloses the oblique incidence according to feature i, it is related to the same concept as the present application contrary to the normal incidence arrangement described in D2. Therefore D1 represents the closest prior art.

2.3 The problem solved over D1 by features ii (forward scattering) and iii (plurality of detectors) and by the short-scan feature addresses the detection of small particles. The solution of the problem has been illustrated by slides which, according to the appellant, show results obtained by the invention for particles having a diameter as small as 20 nm.

2.4 Even though D1, see the paragraph bridging columns 4 and 5, discloses an azimuthal angle range of 80° to 100°, including the detection of radiation scattered under an angle slightly less than 90°, the skilled person would understand this as teaching the detection of radiation in a direction substantially perpendicular to the incident beam, and as far away as possible from the 0° direction, so as to minimise collection of light diffracted by the surface pattern (see paragraph bridging columns 4 and 5). There is thus no teaching in document D1 "to collect radiation scattered from the surface, including radiation scattered along the scan path in the forward direction azimuthally", in accordance with the wording employed in present claim 1, which, in the Board's view, implies deviation from the 90° scattering direction.

2.5 It is evident that documents D2 and PCT1 disclosing normal incidence are not relevant to the oblique arrangement of D1. Documents D3 and D4 are even less relevant.

2.6 Therefore the Board concludes that just by way of the additional limitations in relation to the forward scatter direction of the detected radiation, the subject-matter of claim 1 and that of claim 23 relating to a corresponding method is novel and involves an inventive step.

3. The dependent claims are related to embodiments of the present invention. The description has been adapted to the amended claims and meets the requirements of the EPC as to the presentation of the relevant prior art and the present invention in terms of problem and solution.

4. Since the main request of the appellant is granted there is no need to consider the auxiliary request.

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 in the following version:

Description:

Pages: 1, 2 and 8 to 27 as published.

Pages: 3 filed during the oral proceedings on 12 January 2010.

Pages: 4 to 5 and 7, filed with letter dated 10 May 2006.

Claims: 1 to 45 according to the main request filed with letter dated 12 December 2009.

Drawings: Sheets 1/6 to 6/6 as published.

The Registrar: The Chairman:

M. Kiehl A. G. Klein