Datasheet for the decision of 2 December 2010

Case Number: T 1466/07 - 3.4.03
Application Number: 00926076.1
Publication Number: 1218933
IPC: H01L 21/66
Language of the proceedings: EN

Title of invention: Method and apparatus for performing run-to-run control in a batch manufacturing environment

Applicant: GlobalFoundries, Inc.

Opponent: -

Headword: -

Relevant legal provisions: -

Relevant legal provisions (EPC 1973): EPC Art. 84

Keyword: "Lack of support by the description"

Decisions cited: -

Catchword: -
Case Number: T 1466/07 - 3.4.03

DECISION
of the Technical Board of Appeal 3.4.03
of 2 December 2010

Appellant: GlobalFoundries, Inc.
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Decision under appeal: Decision of the Examining Division of the European Patent Office posted 12 February 2007 refusing European patent application No. 00926076.1 pursuant to Article 97(1) EPC.

Composition of the Board:
Chairman: G. Eliasson
Members: V. L. P. Frank
P. Mühlen
Summary of Facts and Submissions

I. This is an appeal from the refusal of application 00 926 076 for lack of support by the description (Article 84 EPC 1973) and added subject-matter (Article 123(2) EPC 1973).

II. As announced with the letter dated 12 November 2010 the appellant applicant was not represented at the oral proceedings before the board.

The appellant applicant requested in writing that the decision under appeal be set aside and that a patent be granted on the basis of the main request or on the basis of one of the first to fifth auxiliary requests, all filed with the letter of 12 October 2010.

III. Claim 1 of the main request reads:

"1. A method for controlling a manufacturing process using a hierarchical system, comprising:
processing a first lot of semiconductor devices (105) using a first set of control input parameters;
storing said first set of control input parameters in one of a plurality of hierarchical levels (602-678), of a control thread, said first set of control input parameters being available for processing of a second lot of semiconductor devices (105) subject to said control thread; the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the second lot of semiconductor devices of said thread;
acquiring process data from said processing of said first lot of semiconductor devices (105); determining a second set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data; storing said second set of control input parameters in one of a plurality of hierarchical levels (602-678) of said control thread, said first and second sets of control input parameters being available for processing of a third lot of semiconductor devices (105) subject to said control thread, the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the third lot of semiconductor devices of said thread, and implementing the first and second stored sets of control input parameters in a subsequent semiconductor device processing sequence for the third lot of semiconductor devices (105)."

Claim 1 of the 1st auxiliary request reads:

"1. A method for controlling a manufacturing process using a hierarchical system, comprising: processing a first lot of semiconductor devices (105) using a first set of control input parameters; storing said first set of control input parameters in a first level of a plurality of hierarchical levels (602-678), of a control thread, said first set of control input parameters being available for processing of a second lot of semiconductor devices (105)."
devices (105) subject to said control thread; the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the second lot of semiconductor devices of said thread; acquiring process data from said processing of said first lot of semiconductor devices (105); determining a second set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data; storing said second set of control input parameters in a second level of a plurality of hierarchical levels (602-678) of said control thread, said first and second sets of control input parameters being available for processing of a third lot of semiconductor devices (105) subject to said control thread, the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the third lot of semiconductor devices of said thread, data in the first hierarchical level having a greater effect on the process relative to data in the second hierarchical level, and implementing the first and second stored sets of control input parameters in a subsequent semiconductor device processing sequence for the third lot of semiconductor devices (105)."

Claim 1 of the 2nd auxiliary request reads:

"1. A method for controlling a manufacturing process using a hierarchical system, comprising:
processing a first lot of semiconductor devices (105) using a first set of control input parameters; storing said first set of control input parameters in a first one of three hierarchical levels (602-678), of a control thread, said first set of control input parameters being available for processing of a second lot of semiconductor devices (105) subject to said control thread; the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the second lot of semiconductor devices of said thread; acquiring process data from said processing of said first lot of semiconductor devices (105); determining a second set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data; and storing said second set of control input parameters in a second one of three hierarchical levels (602-678) of said control thread, said first and second sets of control input parameters being available for processing of a third lot of semiconductor devices (105) subject to said control thread, the hierarchical levels being ordered according to the relative impact control thread data each in level will have on the processing of the third lot of semiconductor devices of said thread. determining a third set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data; and
storing said third set of control input parameters in a third one of three hierarchical levels (602-678) of said control thread, said first, second and third sets of control input parameters being available for processing of a fourth lot of semiconductor devices (105) subject to said control thread, the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the fourth lot of semiconductor devices of said thread; wherein data in the first level has a greater effect on the process than data in the second level, and data in the second level has a greater effect than data in the third level, and implementing the first and second stored sets of control input parameters in a subsequent semiconductor device processing sequence for the third lot of semiconductor devices (105).

Claim 1 of the 3rd auxiliary request reads:

"1. A method for controlling a manufacturing process using a hierarchical system, comprising:
performing an overlay process on a first lot of semiconductor devices (105) using a first set of control input parameters;
storing said first set of control input parameters in one of a plurality of hierarchical levels (602-678), said first set of control input parameters being available for performing an overlay process on a second lot of semiconductor devices (105); the hierarchical levels being arranged in order of the relative impact each level will have on
performing said overlay process on the second lot of semiconductor devices;
acquiring process data from said processing of said first lot of semiconductor devices (105);
determining a second set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data;
storing said second set of control input parameters in one of a plurality of hierarchical levels (602-678), said first and second sets of control input parameters being available for performing an overlay process on a third lot of semiconductor devices (105), the hierarchical levels being arranged in order of the relative impact each level will have on the processing of the third lot of semiconductor devices, and implementing the first and second stored sets of control input parameters in a subsequent semiconductor device processing sequence for the third lot of semiconductor devices (105)."

Claim 1 of the 4th auxiliary request reads:

"1. A method for controlling a manufacturing process using a hierarchical system, comprising:
processing a first lot of semiconductor devices (105) using a first set of control input parameters; and
updating process input control parameters for processing semiconductor devices on a run-to-run basis, comprising:
storing said first set of control input parameters in one of a plurality of hierarchical levels (602-
Claim 1 of the 5th auxiliary request reads:

"1. A method for controlling a manufacturing process using a hierarchical system, comprising:

678), of a control thread, said first set of control input parameters being available for processing of a second lot of semiconductor devices (105) subject to said control thread; the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the second lot of semiconductor devices of said thread;

acquiring process data from said processing of said first lot of semiconductor devices (105);

determining a second set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data;

storing said second set of control input parameters in one of a plurality of hierarchical levels (602-678) of said control thread, said first and second sets of control input parameters being available for processing of a third lot of semiconductor devices (105) subject to said control thread, the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the third lot of semiconductor devices of said thread, and

implementing the first and second stored sets of control input parameters in a subsequent semiconductor device processing sequence for the third lot of semiconductor devices (105)."
processing a first lot of semiconductor devices (105) using a first set of control input parameters, wherein the processing is performed by a first stepper tool, and updating process input control parameters for processing semiconductor devices on a run-to-run basis, comprising:

storing said first set of control input parameters in one of a plurality of hierarchical levels (602-678), of a control thread, said first set of control input parameters being available for processing of a second lot of semiconductor devices (105) subject to said control thread; the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the second lot of semiconductor devices of said thread;

acquiring process data from said processing of said first lot of semiconductor devices (105);

determining a second set of control input parameters for a subsequent lot of semiconductor devices (105) based upon said acquired process data; and

storing said second set of control input parameters in one of a plurality of hierarchical levels (602-678) of said control thread, said first and second sets of control input parameters being available for processing of a third lot of semiconductor devices (105) subject to said control thread, the hierarchical levels being ordered according to the relative impact control thread data in each level will have on the processing of the third lot of semiconductor devices of said thread, and
implementing the first and second stored sets of control input parameters in a subsequent semiconductor device processing sequence for the third lot of semiconductor devices (105), wherein the subsequent processing is performed by a second stepper tool.

IV. The appellant applicant argued essentially as follows:

- The entirety of the invention as set forth in claim language should be assessed when taken as a whole and in proper context. In particular, the applicant offered an illustrative and illuminating example for the board's benefit, particularly as claimed in the 4th auxiliary request. Claim 1 recited that a first lot was processed using a first set of input control parameters which were then stored. The stored parameters might then be used to control subsequent processing of a second lot of devices. A second set of control input parameters might be determined based upon data associated with the second lot of devices. A subsequently processed third lot of devices might be controlled by control threads based on the previously processed first and second lots. The claim language hence read upon the description of updating control input parameters on a run-to-run basis.

- The applicant further directed the board's attention to the specification, which recited "exposure tool[s] 110" and described various embodiments in terms of an "exposure tool 110" throughout the description (eg page 3, lines 12 to 31). One example of an "exposure tool 110" explicitly listed in the
specification was a stepper tool. However, it was highly unlikely that a person of skill in the art would not know that an "exposure tool 110" may encompass other exposure tools such as a step-and-scan tool (e.g., a deep ultraviolet exposure tool). Such a position seemed unsupported and untenable. Indeed, the board did not allude to any reason as to why a person of skill in the art would not know of other examples of an "exposure tool 110" and this was not surprising as exposure tools were well known in the art.

Similarly, the board's position that it remained unclear as to how the claimed method and apparatus might be implemented in "other manufacturing processes... (e.g. with a single stepper)" was incorrect. As is described in the specification, a semiconductor device might be processed in an exposure tool and then checked by a review station for errors. After error checking was performed, the semiconductor device might be again placed in an exposure tool for processing. The selection of a particular tool for the second processing step, as described immediately above, might vary between manufacturing processes. In other words, a semiconductor device might then be placed into another exposure tool or placed back into the same exposure tool for additional processing. Applicant submitted that a complete reading of the specification, as cited above, would make this clear to a person of skill in the art.
Reasons for the Decision

1. The appeal is admissible.

2. Support by the description (Article 84 EPC 1973)

2.1 Article 84 EPC 1973 requires inter alia that the claims shall be supported by the description. The requirement that the subject-matter of the claims be supported by the description implies that the claims should relate to what has been described and that it is not allowable to claim something which was not described. However, a purely formal support, ie a verbatim repetition in the description of the wording of the claims, does not meet this requirement.

2.2 The present application relates to a method for controlling a manufacturing process using a hierarchical system in which the parameters (called control input parameters) controlling the manufacturing process are stored. The description illustrates the invention on the basis of an overlay process employed during the manufacture of semiconductor devices. Overlay control involves measuring the misalignment between two successive patterned layers on the surface of a semiconductor device. The result from the analysis of the overlay errors is used to make updates to the control settings for a subsequent run of a lot of semiconductor wafers (page 3, lines 12 to 19; page 4, lines 1 to 6).

2.2.1 The updated control input signals can be implemented by control threads which identify a batch of lots with similar characteristics. For overlay control, the
control threads are separated by a combination of different conditions including the semiconductor manufacturing tool (e.g., stepper) currently processing the wafer lot, the semiconductor product, the semiconductor manufacturing operation and the semiconductor manufacturing tool that processed the semiconducting wafer lot at a previous layer of the wafer (page 5, lines 3 to 11). The present invention teaches a method of hierarchical ordering of the conditions, or attributes, that constitute a control thread. The hierarchical ordering of control thread data is related to the strength of the effects that these conditions exert on the control of the manufacturing process. One example of hierarchical ordering of control thread is as follows. The control inputs of the specific tool used at a process have a major influence on the control inputs of the present process. This can thus be defined as the first level of a hierarchical ordering of the control thread data. The control inputs of the manufacturing tool employed at a previous operation may be the second most influential factor on the control inputs of the present process. This can be defined as the second level of the hierarchical ordering of control thread data. The control inputs relating to a similar product type may be the third most influential factor on the control inputs of the present process and this can be defined as the third level of the hierarchical ordering of control thread data (page 7, lines 15 to 25). The different levels in the hierarchy are therefore arranged in order of the relative impact each of the previous process factors have on the variance of the present manufacturing process.
2.2.2 The application discloses the implementation of the controlling method as follows. The highest relevant hierarchical level that relates to the present process step is determined, ie the control thread that represents the hierarchical level closest to the top hierarchical level related to the present process step is found. When a hierarchical level that contains a control thread that can be utilized for the present process is not found, the default settings are used to determine the new input control settings for the present process step. This new input control setting is then filled into an appropriate bin in a hierarchical level. When a relevant hierarchical level that contains a control thread that can be utilized for the present process is found, the next lower hierarchical level is checked to determine if it contains a control thread that is more closely, or specifically, related to the present process. When a relevant control thread is found in a lower hierarchical level, the next lower hierarchical level is checked. This process is repeated until the lowest hierarchical level that contains a relevant control thread for the current process is found. When the lowest hierarchical level checked does not contain relevant control thread data, the control thread data from the previous hierarchical level is used to control the present process step, ie data from the lowest relevant hierarchical level, which contains the most specific control thread for the present process is used. This data is thus used to generate the new control settings for the present process step (page 8, lines 8 to 33; Figure 5).
2.3 The board finds that the claims of all claim requests are not supported by the description as required by Article 84 EPC 1973, for the following reasons:

2.3.1 Claim 1 of the main, 1\textsuperscript{st}, 2\textsuperscript{nd} and 4\textsuperscript{th} auxiliary requests relate to "A method for controlling a manufacturing process using a hierarchical system, comprising: processing a first lot of semiconductor devices ...", i.e. the claim covers all processes involved in manufacturing a semiconductor device.

2.3.2 The description illustrates the claimed controlling method only on hand of an overlay process using an exposure tool, in particular a stepper machine. The board cannot see how the controlling method disclosed in the description can be applied to all the processes involved in semiconductor device manufacturing. In particular, as semiconductor device manufacture involves a large variety of extremely different and highly sophisticated processes, starting at the photolithographic exposure of the semiconductor wafer, including oxidation of the wafer, deposition and interconnection of subsequent layers and finally assembly and packaging of the device and testing the finished semiconductor device.

2.3.3 The skilled person, by reading the disclosure of the present application, is not put in a position allowing him to implement the claimed controlling method in substantially all semiconductor device manufacturing processes. This was implicitly acknowledged by the appellant applicant when he pointed out that the specification referred to "exposure tool[s] 110", i.e. that it also comprised other exposure tools such as a
step-and-scan tool, and was not limited to a stepper apparatus. However, the method of claim 1 of the main, 1st, 2nd and 4th auxiliary requests is not limited to a method for controlling an exposure tool, but relates to all methods relating to controlling a manufacturing process of a semiconductor device.

2.3.4 Furthermore, claim 1 of all claim requests specifies \textit{inter alia} that:

(a) a first lot of semiconductors is processed using a first set of control input parameters,

(b) this first set of control input parameters is stored in one of the hierarchical levels of the control thread,

(c) process data are acquired from the processing of the first lot of semiconductors (eg the analysis of the misalignment errors in an overlay process),

(d) a second set of control input parameters is determined based upon the acquired process data,

(e) the second set of control input parameters is also stored in one of the hierarchical levels of the control thread

(f) the first and second sets of control parameters are implemented in a subsequent semiconductor device processing sequence for a third lot of semiconductor devices.
2.3.5 These steps are however inconsistent with what is disclosed in the description. According to the description, the overlay error, i.e., the misalignment between two successive patterned layers on the surface of a semiconductor device, is measured. The result from the analysis of the overlay errors is used to make **updates** to the control settings for a subsequent run of a lot of semiconductor wafers (page 3, lines 12 to 19; page 4, lines 1 to 6). It is not disclosed that the updated control settings are stored and that both the original and the updated control setting are employed for processing a further lot of semiconductor devices, as specified in steps (e) and (f) mentioned above. Updating implies the replacement of the previous control settings by new ones, whereby the previous control settings become unavailable and can no longer be employed for processing further lots. This, however, is not what is being claimed.

2.3.6 The board judges for these reasons that the method of claim 1 of all requests is not supported by the description.
Order

For these reasons it is decided that:

The appeal is dismissed.

Registrar       Chair

S. Sánchez Chiquero       G. Eliasson