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[Continued on next page]

(54) Title: SMART TEMPERATURE MEASURING DEVICE

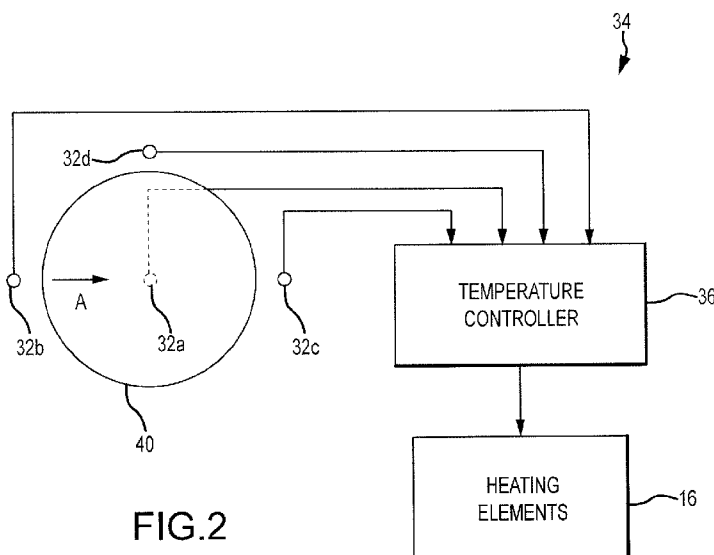


FIG.2

(57) Abstract: A temperature measuring device having a smart chip, or electronic circuit, integrated therein is provided. The smart chip, or electronic circuit, includes at least a unique identification number or data specific to the particular temperature measuring device stored thereon. The electronic circuit further includes calibration data of the temperature measuring device stored thereon. A module controller of a temperature control system is configured to verify the unique identification number of the thermocouple assembly prior to allowing data to be transferred between the temperature measuring device and a temperature controller. A graphical user interface allows an operator to enter the unique identification number or data to verify the temperature measuring device and display an error message if the number or data entered is not equivalent, or does not match, the unique identification number or data stored on the electronic circuit.

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— *with international search report (Art. 21(3))*

SMART TEMPERATURE MEASURING DEVICE

5 FIELD OF THE INVENTION

The present invention relates to a temperature measuring device, and more particularly to a temperature measuring device configured to enhance accuracy of temperature control in a semiconductor processing apparatus.

10 BACKGROUND OF THE INVENTION

Temperature controlled semiconductor processing chambers are used for depositing various material layers onto a substrate surface or surfaces. In processing substrates within the processing chamber, one or more substrates or workpieces, such as silicon wafers, are placed on a workpiece support within the processing chamber. Both the substrate and workpiece support are heated to a desired temperature. In a typical processing step, reactant gases are introduced into the processing chamber and passed over each heated substrate, whereby a chemical vapor deposition (CVD) or an atomic layer deposition (ALD) process deposits a thin layer of the reactant material in the reactant gases on the substrate surface(s). Through subsequent processes, these layers are formed into integrated circuits, and tens to thousands or even millions of integrated devices, depending on the size of the substrate and the complexity of the circuits, are cut from the processed substrate.

Various process parameters must be carefully controlled to ensure the high quality of the resulting deposited layers. One such critical parameter is the temperature of the substrate during each processing step. During CVD, for example, the deposition gases react at particular temperatures to deposit the thin layer on the substrate. If the temperature varies greatly across the surface of the substrate, the deposited layer could be uneven. Accordingly, it is important that the substrate temperature be stable and uniform at the desired temperature during processing of the substrate. Similarly, non-uniformity or instability of temperatures across a substrate during other thermal treatments can affect the uniformity of resulting structures on the surface of the substrate. Other processes for which temperature control can be critical include, but are not limited to, oxidation, nitridation, dopant diffusion, sputter depositions, photolithography, dry etching, plasma processes, and high temperature anneals.

Methods and systems are known for measuring the temperature at various locations near and immediately adjacent to the substrate being processed. Typically, thermocouple assemblies are disposed at various locations near the substrate being processed, and these thermocouple assemblies are operatively connected to a controller to assist in providing a more uniform temperature across the entire surface of the substrate. For example, U.S. Patent No. 6,121,061 issued to Van Bilsen generally teaches a plurality of temperature sensors measuring the temperature at various points surrounding the substrate, including a thermocouple assembly placed near the leading edge of the substrate, another near the trailing edge, one at a side, and another below the substrate near the center of the substrate.

A problem often associated with the replacement of thermocouple assemblies, either because of failure or for regular maintenance, is the variability between each thermocouple assembly. The variability between each thermocouple assembly may be due to any number of factors including, but not limited to, materials used or the methods for producing the thermocouple assemblies. The variability of each thermocouple assembly may result in varying temperature measurements, or a different temperature measurement at the same temperature relative to a previous thermocouple assembly, which in turn may affect the deposition process if the measured temperature is substantially different than the actual temperature within the reaction chamber. Because the temperature control system is based on the calibrated temperature measured by each thermocouple assembly connected to the system, any variability of the calibration between successive thermocouple assemblies will cause variations in the temperature control scheme that may lead to non-uniform deposition of layers on the substrates.

A need therefore exists for a temperature measuring device that includes pre-calibrated parameters such that the deposition tool can be automatically adjusted to account for the pre-calibrated parameters of the temperature measuring device. A need also exists for a temperature measuring device in which pre-calibrated parameters are integrally included with the temperature measuring device.

BRIEF SUMMARY OF THE INVENTION

In one aspect of the present invention, a thermocouple assembly is provided. The thermocouple assembly includes at least one thermocouple junction for measuring temperature. The thermocouple assembly also includes an electronic circuit on which

calibration data and a unique identification number is stored. The thermocouple junction is operatively connected to the electronic circuit.

In another aspect of the present invention, a temperature control system is provided. The temperature control system includes at least one heating element and a temperature
5 controller. Each heating element(s) is operatively connected to the temperature controller, and the temperature controller controls output of the heating element(s). The temperature control system further includes a temperature measuring device operatively connected to the temperature controller. The temperature measuring device includes an electronic circuit integrated therein.

10 In yet another aspect of the present invention, a method for verifying a temperature measuring device for a semiconductor processing tool is provided. The method includes providing a temperature measuring device having an electronic circuit integrated therein, wherein the electronic circuit includes at least a unique identification number or data saved thereon. The method also includes providing module controller operatively connected to the
15 temperature measuring device. The method further includes providing a temperature controller operatively connected to the module controller and the temperature measuring device. The method also includes verifying the unique identification number or data saved on said temperature measuring device prior to a transfer of data between the temperature measuring device and the temperature controller or module controller.

20 In a further aspect of the present invention, a method for verifying a temperature measuring device for a semiconductor processing tool is provided. The method includes providing a module controller operatively connected to a temperature controller. The method further includes connecting a temperature measuring device to the module controller, wherein the module controller queries the temperature measuring device for a
25 unique identification number stored on an electronic circuit integrated with the temperature measuring device. The method also includes entering an identification number into a graphical user interface (GUI). The GUI is operatively connected to the module controller. The method also includes comparing the unique identification number stored on the electronic circuit of the temperature measuring device with the identification number entered
30 into the GUI. The method includes allowing data transfer between the temperature measuring device and the temperature controller if the unique identification number stored on the electronic circuit of the temperature measuring device is equivalent to the identification number entered into the GUI. The method further includes preventing data

transfer between the temperature measuring device and the temperature controller if the unique identification number stored on the electronic circuit of the temperature measuring device is not equivalent to the identification number entered into the GUI.

Advantages of the present invention will become more apparent to those skilled in the art from the following description of the embodiments of the invention which have been shown and described by way of illustration. As will be realized, the invention is capable of other and different embodiments, and its details are capable of modification in various respects. Accordingly, the drawing(s) and description are to be regarded as illustrative in nature and not as restrictive.

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BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a side cross-sectional view of an embodiment of a reactor of a semiconductor processing tool;

FIG. 2 is a schematic diagram of an exemplary temperature control system;

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FIG. 3 is an isometric view of an exemplary temperature measuring device; and

FIG. 4 illustrates an electrical schematic diagram of a temperature control system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, an exemplary embodiment of a chemical vapor deposition (“CVD”) reactor 10 is shown. While the illustrated embodiment is a single substrate, horizontal flow, cold-wall reactor, it should be understood by one skilled in the art that the thermocouple technology described herein may be used in other types of semiconductor processing reactors as well as other applications requiring accurate temperature sensors. The reactor 10 includes a reaction chamber 12 defining a reaction space 14, heating elements 16 located on opposing sides of the reaction chamber 12, and a substrate support mechanism 18. The reaction chamber 12 is an elongated member having an inlet 20 for allowing reactant gases to be introduced into the reaction space 14 and an outlet 22 through which the reactant gases and process by-products exit the reaction space 14. In an embodiment, the reaction chamber 12 is formed of transparent quartz that is configured to allow substantially all of the radiant energy from the heating elements 16 to pass through the walls of the reaction chamber 12. The heating elements 16 provide radiant energy to the reaction chamber 12 without appreciable absorption by the reaction chamber 12 walls. The

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heating elements 16 are configured to provide radiant heat of wavelengths absorbed by the substrate being processed as well as portions of the substrate support mechanism 18.

In an embodiment, the substrate support mechanism 18 includes a substrate holder 24 upon which a substrate 40 is disposed during a deposition process, as illustrated in FIG.

5 1. The substrate support mechanism 18 also includes a support member 26 configured to support the substrate holder 24. The support member 26 is connected to a shaft 28 that extends downwardly through a tube 30 extending from the lower wall of the reaction chamber 12. A motor (not shown) is configured to rotate the shaft 28, thereby rotating the substrate holder 24 and substrate 40 in a like manner during the deposition process. A
10 susceptor ring 25 is disposed about the edge of the substrate 40 and substrate holder 24 to counteract the heat loss from the edges therefrom. Temperature measuring devices 32, such as thermocouple assemblies, pyrometers, or the like, are disposed within the susceptor ring 25 to measure the localized temperature at pre-determine positions about the substrate 40 and substrate holder 24.

15 Referring to FIG. 2, an embodiment of a temperature control system 34 within a reaction chamber is illustrated. The illustrated temperature controlling system 34 for a chemical vapor deposition reactor 10 includes a plurality of temperature measuring devices 32 that are located adjacent to the substrate 40 and the substrate holder 24 for measuring temperatures at pre-determined locations. The temperature measuring devices 32 are
20 operatively connected to a temperature controller 36. The temperature controller 36 is operatively connected to the heating elements 16 to control the heating scheme within the reaction chamber 12.

In the schematic diagram of FIG. 2, the illustrated embodiment of the a temperature control system 34 includes a plurality of temperature measuring devices 32 disposed about
25 the substrate 40, wherein the temperature measuring devices 32 include: a central temperature sensor 32a located adjacent to the lower surface of the substrate holder 24, a leading edge temperature sensor 32b, a trailing edge temperature sensor 32c, and at least one side edge temperature sensor 32d. The leading and trailing edge temperature sensors 32b, 32c are located adjacent to the front and rear edges of the substrate 40 relative to the
30 direction of flow A of the reactant gases within the reaction space 14. The temperature measuring devices 32 are configured to measure the temperature in the localized area and transmit temperature measurement data to the temperature controller 36. The temperature controller 36 is configured to selectively adjust the energy emitted from the heating

element(s) 16 in response to data provided by the temperature measuring devices 32 to maintain a substantially uniform temperature distribution across the entire substrate 40 being processed. It should be understood by one skilled in the art that the temperature control system 34 may include any number of temperature measuring devices 32 disposed at
5 different locations within, or external to, the reaction chamber 12 for providing data to the temperature controller 36 of the temperature of the substrate 40 being processed or locations adjacent to the substrate 40.

The temperature measuring devices 32 may include thermocouple assemblies, pyrometers, thermometers, or any other temperature measuring device capable of measuring
10 temperatures within semiconductor manufacturing equipment. In an embodiment, each of the temperature measuring devices 32 is the same as the others. In another embodiment, at least one temperature measuring device 32 is different than the others. In an embodiment, each of the temperature measuring devices 32 is a thermocouple assembly such as the thermocouple assembly described in U.S. Patent Application Serial No. 12/140,809.
15 Although the illustrated temperature control system 34 includes four temperature measuring devices 32, it should be understood by one skilled in the art that the temperature control system 34 may include any number and type of temperature measuring devices 32.

Referring to FIG. 3, an exemplary embodiment of a smart thermocouple assembly 132 is shown. While the preferred embodiments of a temperature measuring device of the
20 present invention are discussed in the context of a thermocouple assembly, one skilled in the art will appreciate that the principles and advantages taught herein will have application to other temperature measuring devices that can be used for measuring temperatures within semiconductor processing reactors or semiconductor manufacturing equipment. In an embodiment, the thermocouple assembly 132 includes a sheath 150, a support member 152,
25 a pair of wires 154, a junction 156, a cap 158, an electronic circuit 160, and a plug 162. The sheath 150 is an elongated, tubular member having a measuring tip 164 that forms a closed end. The opposing end of the sheath 150 forms an open end to which the cap 158 is connected. In an embodiment, the sheath 150 is formed of quartz, however, it should be understood by one skilled in the art that the sheath 150 can be formed of any material
30 sufficient to withstand the temperature variations as well as be substantially inert with respect to the gases introduced into the reaction chamber.

In the embodiment illustrated in FIG. 3, the support member 152 is disposed within the sheath 150 and extends at least a portion of the length of the sheath 150. The support

member 152 is configured to receive the pair of wires 154 therein. In an embodiment, the support member 152 is formed of a ceramic material. In an embodiment, the pair of wires 154 extend from the end of the support member 152 adjacent the measuring tip 164 of the sheath 150 to the electronic circuit 160. The wires 154 are formed of dissimilar metals, and an end of each wire is fused to the end of the other wire to form the junction 156 that provides a thermocouple therebetween. The illustrated embodiment shows the junction 156 being located adjacent the measuring tip 164 of the sheath 150, but it should be understood by one skilled in the art that the thermocouple assembly 132 may include a plurality of junctions located at any position(s) along the length of the sheath 150.

In an embodiment, the wires 154 operatively connect the junction 156 to the electronic circuit 160 and the plug 162, as shown in FIG. 3. The plug 162 provides an interface between the thermocouple assembly 132 and the temperature controller 36, as illustrated in FIG. 4. The plug 162 provides a physical connection between the thermocouple assembly 132 and the temperature controller 36, but it should be understood by one skilled in the art that the thermocouple assembly 132 may alternatively include a wireless transmitter (not shown) to operatively connect the thermocouple assembly 132 to the temperature controller 36 without requiring a physical connection therebetween.

As illustrated in FIGS. 3-4, the junction 156 is operatively connected to the electronic circuit 160. The illustrated embodiment shows the electronic circuit 160 positioned between the cap 158 and the plug 162, but it should be understood by one skilled in the art that the electronic circuit 160 can be located at any position between the junction and the interface to which the thermocouple assembly 132 is connected. In an embodiment, the electronic circuit 160 is integrated within the cap 158. In another embodiment, the electronic circuit 160 is integrated within the plug 162. It should be understood by one skilled in the art that the electronic circuit 160 can be located at any location on the thermocouple assembly 132 while maintaining an operative connection to the junction 156.

During assembly of the thermocouple assembly 132, the thermocouple assembly 132 is calibrated using a National Institute of Standards and Technology (NIST) traceable calibration device to verify the accuracy of the thermocouple assembly 132. Also during assembly of the thermocouple assemblies 132, each thermocouple assembly 132 is provided with a unique identification number or data, such as a serial number or the like, that is specific to that thermocouple assembly. The calibration data and the unique identification number are stored on the electronic circuit 160 and travel with and within the smart

thermocouple assembly 132. It should be understood by one skilled in the art that other data or identifiers may also be stored on the electronic circuit 160 in addition to the calibration data and the unique identification number. In an embodiment, the electronic circuit 160 includes a data storage device on which the calibration data and the unique identification number of the thermocouple assembly 132 are stored. In an embodiment, the electronic circuit 160 includes an electrically erasable programmable read-only memory (EEPROM) on which the calibration data and unique identification number are stored. In another embodiment, the electronic circuit 160 includes a flash memory on which the calibration data and unique identification number are stored. It should be understood by one skilled in the art that any other data storage device on which the calibration data and the unique identification number of the thermocouple assembly are stored can be incorporated with the electronic circuit 160. It should also be understood by one skilled in the art that the calibration data and unique identification number may be stored on the same memory device or different memory devices within the electronic circuit 160.

The smart thermocouple assembly 132 is configured to improve the accuracy and performance of the temperature control system 34 by providing verification of the thermocouple assembly as well as providing pre-calibration settings to reduce or eliminate the time and effort needed to calibrate thermocouple assemblies once they are installed. The smart thermocouple assembly 132 is also configured to ensure the proper type of temperature measuring device is used with the temperature control system 34, thereby allowing proper communication therebetween the thermocouple assembly and the temperature control system 34. The smart thermocouple assembly 132 will also reduce the probability of error due to incorrect or inadequate calibration data because the thermocouple assembly is pre-calibrated using a calibration device as opposed to on-the-fly calibration after installation in the reactor 10 (FIG. 1).

FIG. 4 illustrates an exemplary schematic of a temperature control system 34 having an operative connection between the smart thermocouple assembly 132 and the temperature controller 36 of the temperature control system 34. As previously described, the thermocouple junction 156 is operatively connected to the electronic circuit 160 integrated within the thermocouple assembly 132. When the thermocouple assembly 132 is installed, the thermocouple assembly 132 is operatively connected to the temperature controller 36 by way of a module controller 166. A graphical user interface (GUI) 168 is also operatively connected to the module controller 166. The GUI 168 provides an interface between the

operator and the module controller 166 whereby information can be transferred between the GUI 168 and the module controller 166. The module controller 166 is configured to verify the thermocouple assembly 132 connected to the temperature controller 36 prior to data, or a temperature measurement, being transferred from the thermocouple assembly 132 to the temperature controller 36. In other words, the module controller 166 acts as a switch between the thermocouple assembly 132 and the temperature controller 36 such that temperature measurements from the junction 156 are not transferred to the temperature controller prior to the module controller 166 verifying the thermocouple assembly 132.

In operation, an operator installing the thermocouple assembly 132 into a reactor 10 operatively connects the thermocouple assembly 132 to the module controller 166. Once the thermocouple assembly 132 is operatively connected, the module controller 166 transmits a signal to the electronic circuit 160 to query the electronic circuit 160 for the unique identification number or data stored thereon. If a thermocouple assembly 132 is installed in the reactor 10 that does not include a electronic circuit 160 integrated therein, the module controller 166 receives no return transmission or data from the thermocouple assembly and then transmits a signal to the GUI 168 to provide an error message to the operator indicating that the thermocouple assembly 132 is not compatible with the temperature control system 34. If the thermocouple assembly 132 does include a electronic circuit 160 integrated therein, the electronic circuit 160 transmits a signal to the module controller 166 that includes the unique identification number or data of the particular thermocouple assembly 132. Once the module controller 166 receives the unique identification number or data from the electronic circuit 160, the module controller 166 queries the operator to enter the same unique identification number or data that corresponds to the particular thermocouple assembly 132 for confirmation and verification of the unique identification number or data of the particular thermocouple assembly 132 via the GUI 168. Once the operator has entered an identification number or data, the identification number or data is transmitted to the module controller 166. The modular controller 166 compares the unique identification number of the thermocouple assembly 132 with the identification number or data entered by the operator. If the identification number or data is not equivalent to the unique identification number or data of the particular thermocouple assembly 132, the module controller 166 transmits a signal to the GUI 168 to instruct the GUI 168 to display an error message for the operator to indicate that the identification number or data that the operator entered did not correspond with the unique identification number or data of the particular

thermocouple assembly 132. The module controller 166 also prevents the transfer of data between the thermocouple assembly 132 and the temperature controller 36 when the identification number or data input by the operator into the GUI 168 does not correspond to the unique identification number or data of the particular thermocouple assembly 132.

5 The process for verification of the thermocouple assembly 132 explained above can be performed at any time after the thermocouple assembly 132 is installed and operatively connected to the module controller 166. In an embodiment, the verification process is performed immediately after the thermocouple assembly 132 is operatively connected to the
10 module controller 166. In another embodiment, the verification process is performed immediately prior to the operation of the reactor 10 such that processing of a substrate 40 within the reactor 10 will begin only after the thermocouple assembly 132 is verified. Verifying the thermocouple assembly 132 immediately prior to processing within the reactor 10 ensures that another thermocouple assembly 132 was not switched, because switching of the thermocouple assembly 132 may result in poor processing results due to different
15 calibration data of different thermocouple assemblies. In yet another embodiment, the verification process can be performed at regular intervals during processing, for example, between processing a random pair of substrates. It should be understood by one skilled in the art that the thermocouple assembly verification process can be performed at any time to ensure the proper thermocouple assembly 132 is being used during processing to ensure
20 optimized processing results.

 If the operator enters an identification number or data into the GUI 168 that corresponds to the unique identification number or data of the particular thermocouple assembly 132, the module controller 166 compares the unique identification number of the thermocouple assembly 132 with the identification number or data entered by the operator to
25 determine the numbers or data are equivalent and verifies the thermocouple assembly 132. Once the thermocouple assembly 132 has been verified, the module controller 166 transmits a signal to the electronic circuit 160 to query the electronic circuit 160 for the calibration data stored thereon. The electronic circuit 160 then transfers the calibration data to the temperature controller 36 either directly or via the module controller 166. The temperature
30 controller 36 receives the calibration data and adjusts the temperature control system 34 accordingly. Once the module controller 166 has verified the thermocouple assembly 132 and the calibration data on the electronic circuit 160 is transferred to the temperature control

system 34, data and information can freely be transmitted between the thermocouple assembly 132 and the temperature controller 36.

Verification of the temperature measuring device having an integrated electronic circuit 160 reduces the possibility of error in the temperature measuring device by ensuring the temperature measuring device was properly calibrated prior to installation. Verification of the temperature measuring device having an integrated electronic circuit 160 also reduces the possibility of error in the temperature measuring device by confirming that only temperature measuring devices having an electronic circuit that has calibration data of the temperature measuring device and a unique identification number or data stored thereon are being used in the semiconductor processing tool. This verification process further reduces the amount of time necessary for an operator to install or replace a temperature measuring device in the reactor by integrating the calibration data into the temperature measuring device assembly.

The smart temperature measuring device described above was directed to a thermocouple assembly as the measuring device, but it should be understood by one skilled in the art that the technology for validating and confirming the temperature measuring device can be incorporated with any other temperature measuring device, including a pyrometer, a thermometer, or the like.

While preferred embodiments of the present invention have been described, it should be understood that the present invention is not so limited and modifications may be made without departing from the present invention. The scope of the present invention is defined by the appended claims, and all devices, process, and methods that come within the meaning of the claims, either literally or by equivalence, are intended to be embraced therein.

CLAIMS

What is claimed is:

1. A thermocouple assembly comprising:
at least one thermocouple junction for measuring temperature; and
5 an electronic circuit on which calibration data and a unique identification number is stored, wherein said at least one thermocouple junction is operatively connected to said electronic circuit.
2. The thermocouple assembly of Claim 1, wherein said electronic circuit includes an electrically erasable programmable read-only memory (EEPROM).
- 10 3. The thermocouple assembly of Claim 2, wherein at least one of said unique identification number is stored on said EEPROM.
4. The thermocouple assembly of Claim 1, wherein said electronic circuit includes a flash memory.
5. The thermocouple assembly of Claim 2, wherein at least one of said unique
15 identification number is stored on said flash memory.
6. The thermocouple assembly of Claim 1, wherein a plurality of junctions are operatively connected to said electronic circuit.
7. A temperature control system comprising:
at least one heating element;
20 a temperature controller, wherein each of said at least one heating element is operatively connected to said temperature controller and said temperature controller controls output of said at least one heating element; and
a temperature measuring device operatively connected to said temperature controller, said temperature measuring device having an integrated electronic circuit.
- 25 8. The temperature control system of Claim 7, wherein said temperature measuring device wirelessly communicates with said temperature controller.
9. The temperature control system of Claim 7 further comprising calibration data and a unique identification number stored on said electronic circuit.
- 30 10. The temperature control system of Claim 7 further comprising a module controller operatively connected to said temperature measuring device and said temperature controller.

11. The temperature control system of Claim 10, wherein said module controller verifies a unique identification number of said temperature measuring device before data is transferable between said temperature measuring device and said temperature controller.

12. The temperature control system of Claim 11, wherein a graphical user interface (GUI) is operatively connected to said module controller.

13. A method for verifying a temperature measuring device for a semiconductor processing tool, said method comprising:

providing a temperature measuring device having an electronic circuit integrated therein, wherein said electronic circuit includes at least a unique identification number or data saved thereon;

providing module controller operatively connected to said temperature measuring device;

providing a temperature controller operatively connected to said module controller and said temperature measuring device; and

verifying said unique identification number or data saved on said temperature measuring device prior to a transfer of data between said temperature measuring device and said temperature controller.

14. The method of Claim 13, wherein verifying said unique identification number or data includes entering said unique identification number or data corresponding to said temperature measuring device into a graphical user interface operatively connected to said module controller.

15. The method of Claim 14, wherein verifying said unique identification number or data includes the module controller comparing said unique identification number with said unique identification number or data entered by said operator.

16. The method of Claim 15, wherein verifying said unique identification number or data prevents transfer of data between said temperature measuring device and said temperature controller if said unique identification number of said temperature measuring device is not equivalent to said unique identification number entered by said operator.

17. The method of Claim 15, wherein verifying said unique identification number or data allows transfer of data between said temperature measuring device and said temperature controller if said unique identification number of said temperature measuring device is equivalent to said unique identification number entered by said operator.

18. A method for verifying a temperature measuring device for a semiconductor processing tool, said method comprising:

providing a module controller operatively connected to a temperature controller;

5 connecting a temperature measuring device to said module controller, wherein said module controller queries said temperature measuring device for a unique identification number stored on an electronic circuit integrated with said temperature measuring device;

entering an identification number into a graphical user interface (GUI), said GUI operatively connected to said module controller;

10 comparing said unique identification number stored on said electronic circuit of said temperature measuring device with said identification number entered into said GUI;

allowing data transfer between said temperature measuring device and said temperature controller if said unique identification number stored on said electronic circuit of said temperature measuring device is equivalent to said identification number entered into said GUI; and

15 preventing data transfer between said temperature measuring device and said temperature controller if said unique identification number stored on said electronic circuit of said temperature measuring device is not equivalent to said identification number entered into said GUI.

19. The method of Claim 18 further comprising displaying an error message on said GUI if said unique identification number stored on said electronic circuit of said temperature measuring device is not equivalent to said identification number entered into said GUI.

20. The method of Claim 18 further comprising downloading calibration data of said temperature measuring device stored on said electronic circuit to said temperature controller if said unique identification number stored on said electronic circuit of said temperature measuring device is equivalent to said identification number entered into said GUI.

1/4

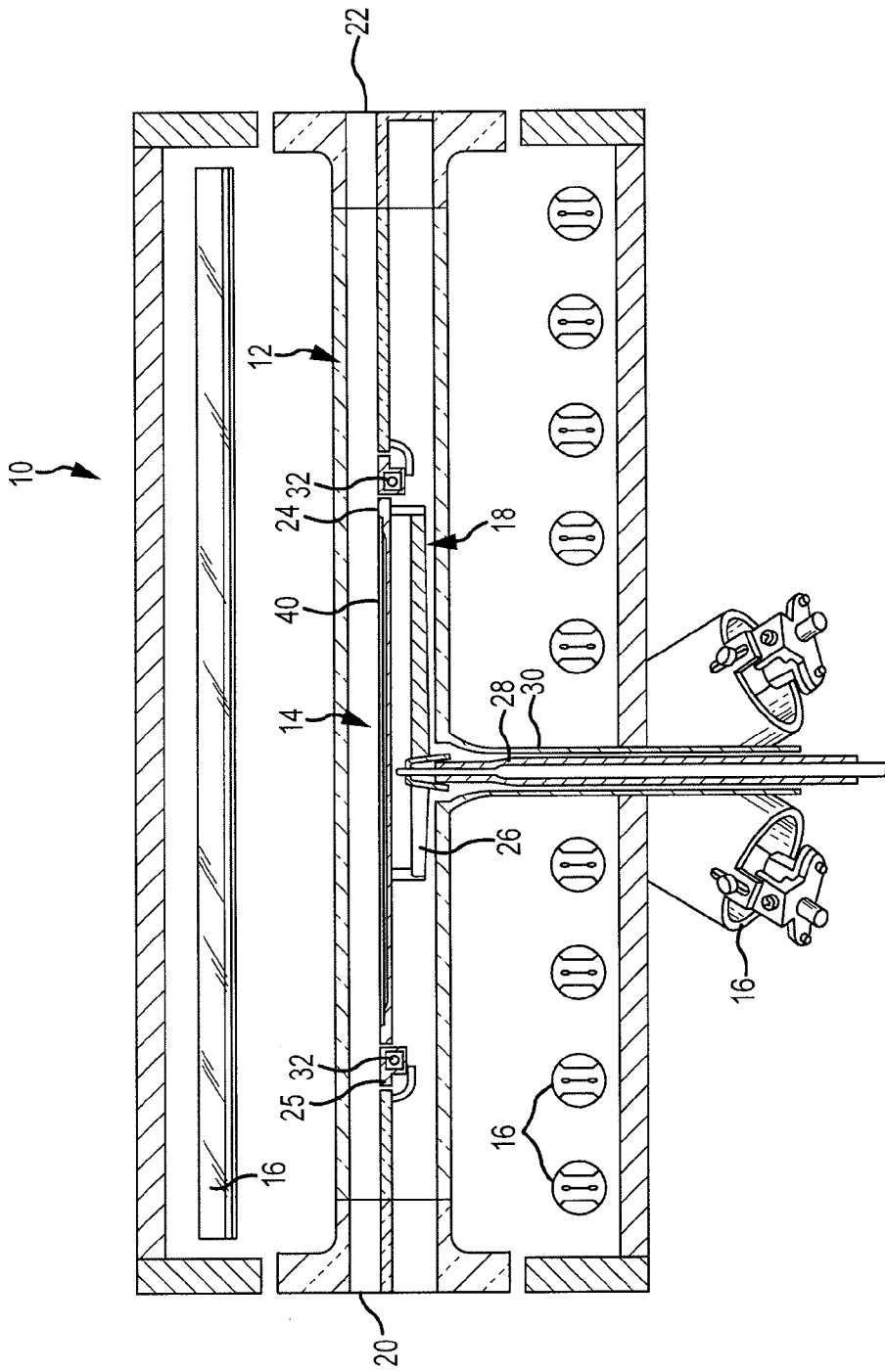


FIG. 1

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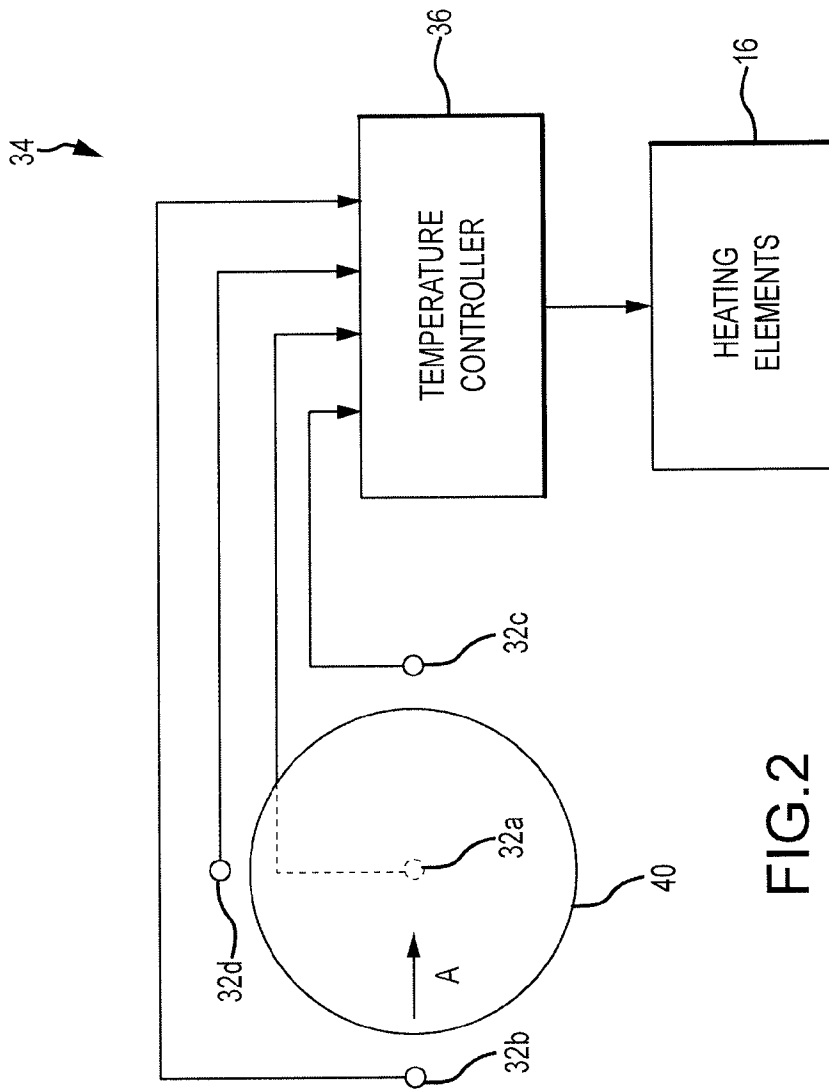


FIG.2

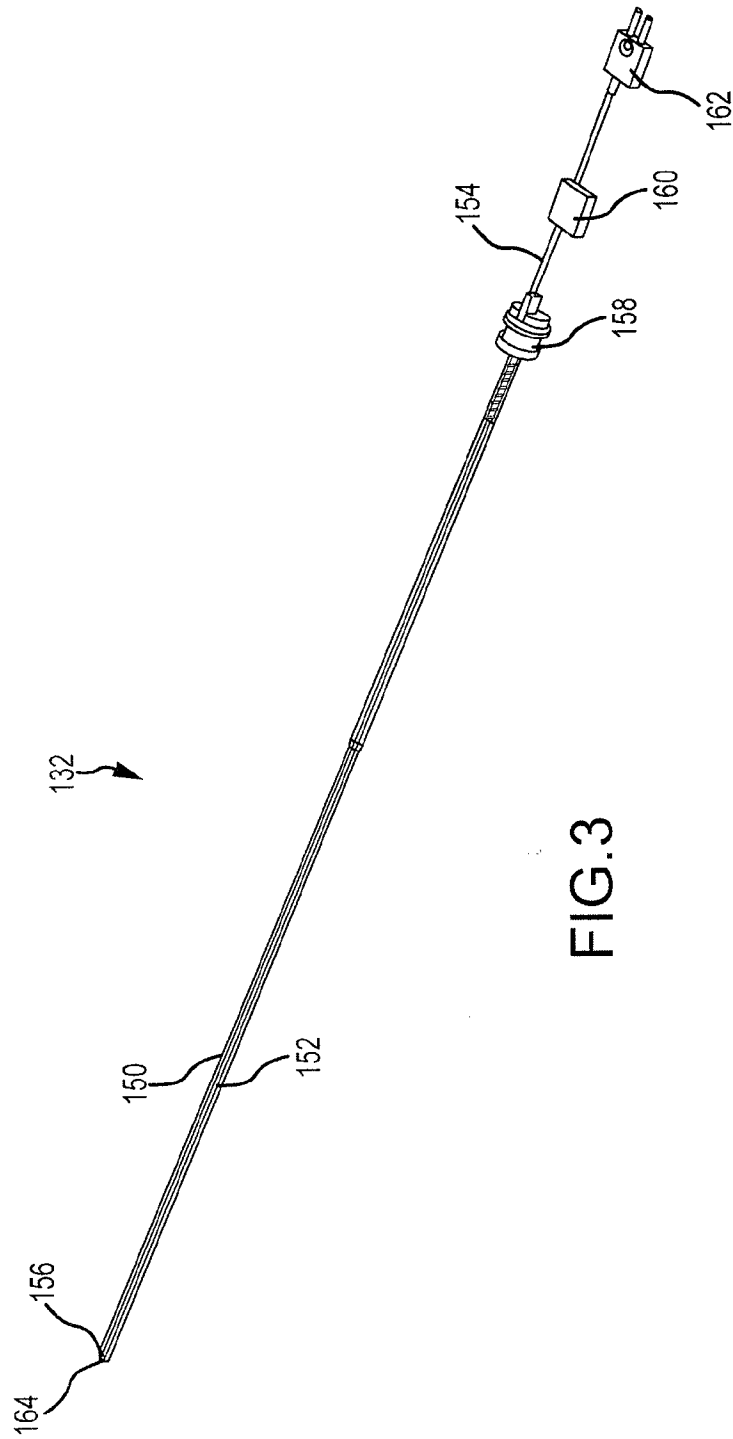


FIG. 3

4/4

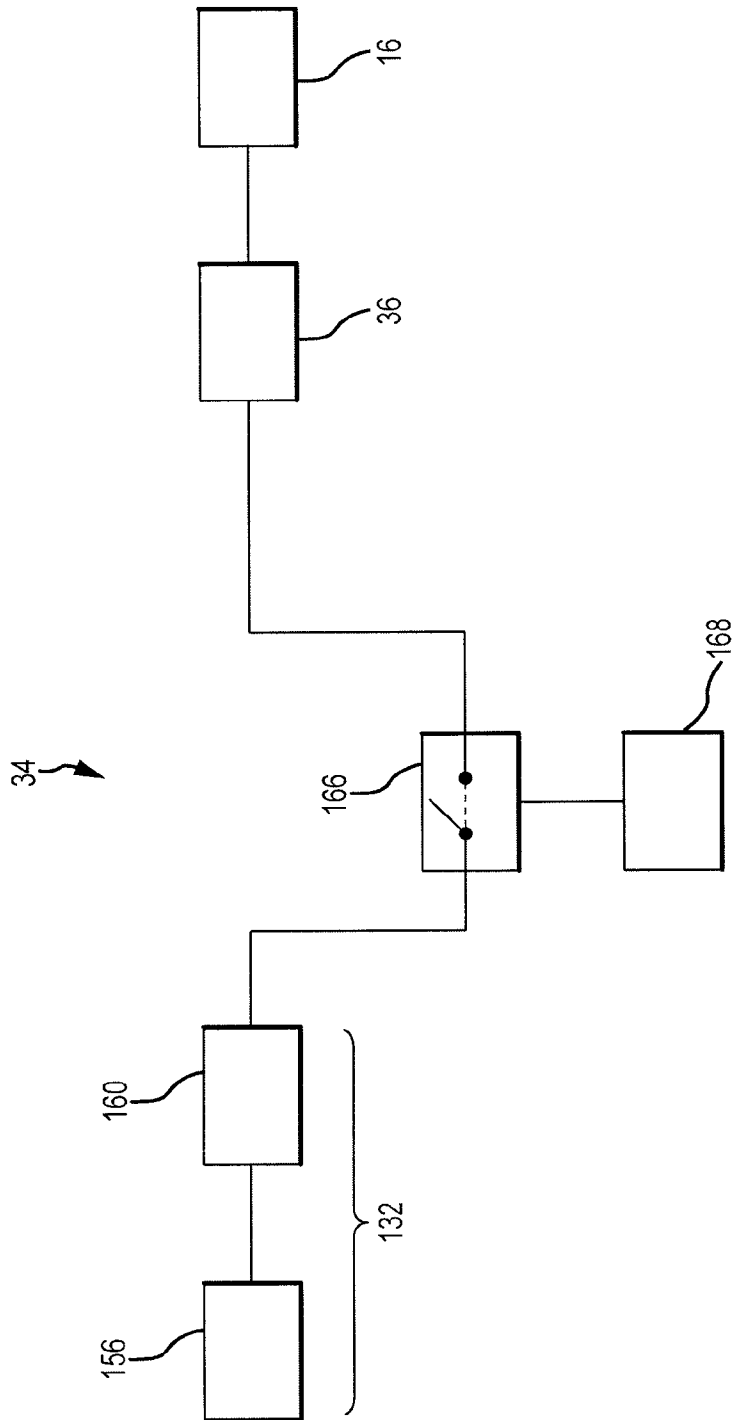


FIG.4

A. CLASSIFICATION OF SUBJECT MATTER**G01K 7/02(2006.01)i, G01K 1/20(2006.01)i, G01K 1/00(2006.01)i, H01L 21/66(2006.01)i, G05D 23/22(2006.01)i, G05D 23/19(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01K 7/02; A61B 5/00; G01K 1/00; G01K 1/02; G01K 1/14; G01K 7/00; G01K 7/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: "temperature","memory","remote","calibration"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005-0101843 A1 (QUINN, D.E. et al.) 12 May 2005	1-15
Y	See figures 1 and 6; paragraphs [0046]-[0055].	16-20
Y	JP 09-089676 A (CASIO COMPUT. CO., LTD.) 04 April 1997 See figures 1-3; claim 4.	16-20
A	US 2003-0002562 A1 (YERLIKAYA, Y.D. et al.) 02 January 2003 See figure 1; claims.	1-20
A	JP 2004-113270 A (PEGASUS NET CO., LTD. et al.) 15 April 2004 See figure 1; abstract.	1-20
A	US 2005-0141591 A1 (SAKANO, M.) 30 June 2005 See figure 1; abstract.	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 JULY 2010 (29.07.2010)

Date of mailing of the international search report

29 JULY 2010 (29.07.2010)

Name and mailing address of the ISA/KR

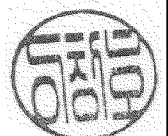
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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