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(54) Title: SAMPLE BLOCK HOLDER

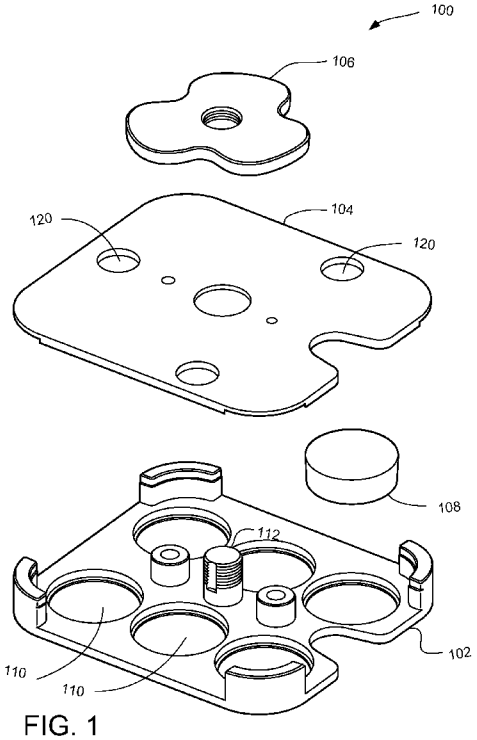


FIG. 1

(57) Abstract: A sample holder assembly includes a sample tray, a base plate, a stage mount, and a calibration standard mounted onto the stage mount. Three mating structures on the bottom of the base plate mate with corresponding structures on a stage mount that is attached to the sample stage of the SEM. An optional contacting conductor provides electrical contact between the stage mount and the base plate so that charge generated on the sample by the electron beam can leave the sample through the sample conductive layer to the sample tray, to the base plate, to the stage mount, and through the grounded stage.

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Sample Block Holder

Technical Field of the Invention

[0001] The present invention relates to a sample holder for mineralogical samples for x-ray spectroscopic analysis.

Background of the Invention

[0002] Mineral analysis systems, such as the Qemscan and MLA from FEI Company, have been used for many years to determine minerals present in mines in order to determine the presence of valuable minerals. Such systems direct an electron beam toward the sample and measure the energy of X-rays coming from the material in response to the electron beam. One such process is called "energy dispersive x-ray analysis" or "EDS," which can be used for elemental analysis or chemical characterization of a sample.

[0003] In EDS analysis, a high-energy beam of charged particles such as electrons or protons, or a beam of X-rays, is focused into the sample being studied to stimulate the emission of X-rays from the sample. The energy of the X-rays emitted from a specimen is characteristic of the atomic structure of the elements making up the specimen. By measuring the number and energy of the X-rays emitted from a specimen using an energy-dispersive spectrometer and comparing the measured spectra to a library of reference spectra of known compositions, the unknown elemental composition of the specimen can be determined. EDS analysis, especially when coupled with back-scattered electron (BSE) analysis, can also be used to quantify a wide range of mineral characteristics, such as mineral abundance, grain size, and liberation. Mineral texture and degree of liberation are fundamental properties of ore and drive its economic treatment, making this type of data invaluable to geologists, mineralogists, and metallurgists who engage in process optimization, mine feasibility studies, and ore characterization analyses.

[0004] Mineral analysis systems of this type are also used in the oil and gas industry, as well as mines. Drill cuttings (drill bit-induced rock chips) and diamond drill cores can be analyzed to allow geologists to determine the exact nature of the material encountered during drilling, which in turn allows more accurate predictions as to the material still ahead of the drill, thus reducing risk in exploration and production. During drilling, a liquid referred to as "mud" is injected into the well to lubricate the drill and return the cuttings out of the well. A sample can be taken from the mud that includes cuttings from the drill. Great importance is often placed on documenting cuttings and cores as accurately as possible, both at the time of drilling and post-drilling. Characterizing down-hole lithological variation in a reservoir

sequence is a critical requirement in exploration wells and production wells, and mineralogical and petrographic studies underpin the fundamental understanding of reservoir and seal characteristics. Traditional optical, scanning electron microscope (SEM), electron probe microanalysis (EPMA), and X-ray diffraction (XRD) analysis methods are well established and widely used within the industry.

[0005] Samples for use in analytical instruments such as Qemscan and MLA systems are prepared so that the material to be analyzed is presented to the instrument as a flat, carbon coated surface within a sample block, typically 30 mm in diameter. Material to be analyzed, such as material retrieved from a mine, is carefully sampled from the mine, crushed, and mixed with epoxy in a mold. The sample is cured and then the sample block is removed. The sample block is ground and polished to expose the interior of some of the particles and to produce a smooth surface. The surface is coated with a carbon film to form a conductive coating to prevent electrical charging by the electron beam.

[0006] The sample block is then placed into a sample holder and clamped in place. Exchange of the older style sample holders requires operator skill and an understanding of the mating surfaces, careful alignment conducted by eye and, in some instances, use of a tool. Manually aligning by operator eye can be difficult and is a frequent source of error. If the sample holder is not seated and aligned correctly, which can only be confirmed by completing system set up, the whole process may need to be redone. That is, the beam is turned off, the vacuum chamber vented, and the sample holder removed and re-installed. A less experienced operator may fail to recognize that the sample holder is misaligned and make faulty measurements, losing many hours of work.

[0007] Once the sample holder block is correctly positioned, the calibration points need to be re-entered into the software by the operator using both the SEM software controls and manual manipulation of the sample stage. This operation requires a clear understanding of the set up process and the knowledge and ability to complete a stage rotation alignment. The process relies on operator skill and is not readily automated. It would be preferable to have a system that is fast, repeatable, does not require a skilled operator, and is susceptible to automation.

Summary of the Invention

[0008] An object of the invention is to provide a sample holder that facilitates mineralogy applications in the field.

[0009] In a preferred embodiment, a sample holder assembly includes a sample tray, a base plate, a stage mount, and a calibration standard mounted onto the stage mount. Three

mating structures on the bottom of the base plate mate with corresponding structures on a stage mount that is attached to the sample stage of the SEM. An optional contacting conductor provides electrical contact between the stage mount and the base plate so that charge generated on the sample by the electron beam can leave the sample through the sample conductive layer to the sample tray, to the base plate, to the stage mount, and through the grounded stage.

[0010] The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter. It should be appreciated by those skilled in the art that the conception and specific embodiments disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

Brief Description of the Drawings

[0011] For a more thorough understanding of the present invention, and advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which:

[0012] FIG. 1 is an exploded view of a sample holder assembly embodying the present invention.

[0013] FIG. 2 shows a detail of the sample tray component of the sample holder assembly of FIG. 1.

[0014] FIG. 3 shows a top view of the base plate of the sample holder assembly of FIG. 1.

[0015] FIG. 4 is an exploded view showing the sample holder assembly being placed onto the stage mount.

[0016] FIG. 5 is a flow chart showing the preferred steps of using an embodiment of the invention.

Detailed Description of Preferred Embodiments

[0017] Charged particle beam systems for mineral analysis are preferably rugged for use in the field near a mine or a well site. SEMS intended for use in the field are preferably adapted to be used by less skilled technicians and for automation. Such design attributes are also beneficial for SEMS used in laboratories. The alignment of the sample holder is preferably simple, precise, quick, and easily automated.

[0018] A common issue in automated mineralogy is the inability of the beam to automatically return to previously set calibration points for automated system calibration and to return to sample locations for measurement after a sample exchange. If the calibration standard is positioned in the sample holder and removed with the sample holder, the sample holder must be carefully aligned in on the sample stage so that the calibration standard is positioned in a known location with respect to the beam. If the alignment is not correct, the beam will impact at a different point on the calibration sample each time, which could result in erroneous calibration and measurements.

[0019] A preferred robust sample holder system of the present invention ensures precise and repeatable sample and calibration standard positioning and provides that the calibration and sample locations cannot be influenced by differences between operator skill levels. A preferred embodiment allows for greater accuracy and speed in manual operation and for automation by improving the ease of use of the sample holder. Preferred embodiments provide an easier, faster sample exchange process with precise repeatable locating of calibration standards and samples without operator influence on positioning at sample exchange.

[0020] In preferred embodiments, the stage-to-sample holder assembly interface uses complementary aligning structures, such as ball and cone locating interfaces, on the sample holder assembly and the stage mount to locate and orient the sample holder relative to the stage or a stage mount mounted onto the stage. The calibration standard remains on the SEM stage as the sample holder is removed and replaced. The calibration standard provides the operator with a visual locator for correct orientation of sample holder assembly.

[0021] FIG. 1 shows an exploded view of a preferred sample holder assembly 100 including a sample tray 102, a base plate 104, and a knob 106 that secures the sample tray 102 to the base plate 104 by screwing onto shaft 106 extending from the sample tray 102. Multiple sample blocks 108 (one shown) are positioned at the six holes 110 in sample tray 102 and are secured between the sample tray 102 and the base plate 104 when the knob 106 is threaded onto a post 112 extended from sample tray 102 through base plate 104. Base plate 104 includes conical indentation 120 to mate with corresponding mating structures on a stage mount as described below. Knob 106 allows sample holder assembly 100 to be assembled rapidly by an operator without the use of tools, such as screwdrivers.

[0022] FIG. 2 shows a detail of the edge of the hole in sample tray 102. Each sample hole 110 includes a counterbore 204 that provides an indentation 206 that positions the sample block 108 and provides a lip 208 having a diameter smaller than that of the

sample block to prevent the sample block from passing through the hole. FIG. 3 shows a top view of the base plate 104, showing springs 302 that press the sample blocks 108 against the lip 208 to orient the sample at a known and repeatable position in relation to the base plate. The springs or other biasing means ensures the sample surfaces are flat, normal to the beam, and held at a known working distance from the column, as well as to ensure a good electrical contact to allow electrical charges to drain from the sample block 108 to the sample tray 102.

[0023] FIG. 4 shows sample holder assembly 100 (without sample blocks) being positioned onto stage mount 402. Stage mount 402 is secured to a moveable stage (not shown) for a charged particle beam system. A calibration standard holder, such as a calibration column 404, is secured to the stage mount 402. Hemispherical structures 406 mounted onto stage mount 402 provide mating structures for the conical indentations in the bottom of the base plate 104. Biasing means, such as leaf springs 408, provide electrical contact between the stage mount 402 and the sample holder assembly 100. The tension in leaf springs 408 is sufficient to provide electrical contact, but not sufficient to prevent seating of the conical indentations of sample holder 100 fully onto the hemispherical mating surfaces of stage mount 402. Sample holder assembly 100 rests on stage mount 402 without being clamped during operation, with the weight alone of sample holder assembly 100 maintaining the contact between the aligning structures in the sample holder assembly and the aligning structures in the stage mount, therefore maintaining the sample holder in the proper position and orientation. Aperture 410 accommodates knob 106 (FIG. 1) protruding from sample holder assembly 100.

[0024] FIG. 5 is a flow chart showing a method of using a sample holder. The sample holder assembly is loaded by turning the sample tray upside down in step 502 and in step 504, the sample blocks are placed facing down into the sample tray with the sample at one or more of the hole locations. Each hole location includes a counterbore that provides an indentation that positions the sample block and provides a lip having a diameter smaller than that of the sample block to prevent the sample block from passing through the hole. The bottom plate is then placed over the sample tray in step 506. The bottom plate includes a biasing means, such as a spring, at each of the sample block locations to press the sample block against the lip, thereby positioning the top of the sample block at a consistent, known height above the bottom of the sample holder assembly, which assists in rapidly focusing the electron beam. By pressing the sample block into the lip, the spring also ensures a good electrical contact between the conductive top of the sample block and the sample tray.

[0025] The base plate is then secured against the sample tray in step 508, for example, by threading a knob nut onto a shaft extending from the sample tray extending through the base plate. The knob can be easily threaded onto and off of the shaft of the sample tray to rapidly change sample blocks by hand, without the use of tools. Other types of quick clamping devices may also be used to secure the sample tray to the base plate.

[0026] The base plates include three conical indentations. The indentations are preferably manufactured separately and pressed into the base plate. The stage mount includes three hemispherical structures that mate with the three conical indentations on the bottom of the base plate. In step 510, the SEM is opened to provide access to the stage mount. In step 512, the sample holder assembly is set onto the stage mount, with the calibration cylinder fitting into a notch in the sample holder assembly to provide rough positioning of the sample holder assembly, with the rough positioning being sufficiently close so that the hemispherical structures on the stage mount will self align with the conical indentation in the conical indentations to produce a fine alignment. The aligning structures on the base plate and stage mount preferably constrain the sample assembly in six degrees of freedom. The orientation and height of the sample holder assembly, as well as the position, is determined by the aligning structures. Thus, precise positioning facilitates automation by facilitating automatic focusing to the known height. As will be recognized, the use of three conical indentations and three hemispherical structures overconstrains the sample holder assembly in three dimensions. The use of identical indentation and hemispherical structure reduces manufacturing costs, while the overconstraint does not decrease the precision to below an acceptable level. Maintaining the calibration standard in the sample chamber facilitates automation by providing a consistent position for the calibration standard, which position does not change as the samples are loaded and unloaded.

[0027] In accordance with some embodiments of the invention, a sample holder system for a charged particle beam system having a sample chamber with a sample stage comprises a stage mount for being affixed to the stage of a charged particle beam system, the stage mount including three alignment structures, a base plate including three alignment structures, each alignment structure on the base plate structured to mate with a corresponding alignment structure on the stage mount, one of each mating alignment structures on the base plate or on stage mount including a hemispherical portion, a sample tray configured to be removably attachable onto the base plate, the sample tray having multiple holes for positioning sample blocks, a clamp holding the sample tray to the base plate, and a

calibration standard holder secured to the stage mount and remaining on the stage mount as samples are changed in the charged particle beam system.

[0028] In some embodiments, the alignment structures that mate with the three hemispherical portions comprise conical indentations. And in some embodiments, the alignment structures that mate with the three alignment structures on the stage mount comprise hemispherical portions and the three alignment structures on the base plate comprise conical or hemispherical indentations.

[0029] In some embodiments, the combined sample tray and base plate holder with sample blocks is maintained on the sample stage during charged particle beam operation by the weight of the sample holder, without additional restraint. And in some embodiments, the three mating structures on the stage mount are attached to the stage mount using fasteners.

[0030] In some embodiments, the sample holder system further comprises springs positioned on the base plate to press the sample blocks into the sample tray and to repeatably orient the sample blocks relative to the sample tray. And in some embodiments, the sample holder system further comprises springs positioned on the stage mount to ensure electrical contact between the stage mount and the base plate, the springs providing sufficient biasing force to provide electrical contact while still allowing the weight of the sample tray, base plate, and sample blocks to cause the aligning structures to fully engage.

[0031] In accordance with some embodiments of the invention, a method for using a sample holder system for a scanning electron microscope for mineralogical samples comprises placing sample blocks into a sample tray, the sample tray having holes for positioning the sample blocks, placing a base plate behind the sample blocks to maintain the sample blocks in the sample tray, the base plate including three alignment structures, fastening the base plate to the sample tray without tools, placing the assemble sample tray, base plate, and sample blocks onto a stage mount of the scanning electron microscope, the stage mount including alignment structures to mate with the alignment structures on the base plate, the alignment structures on the base plate mating with the alignment structures on the stage mount mating to position and orient the sample blocks in on the stage of the charged particle beam system, and operating the charge particle beam system to analyze the sample in the sample blocks, the assembled sample tray, base plate, and sample blocks resting on the stage mount without being fastened to the stage mount.

[0032] In some embodiments, the method further comprises measuring a calibration standard attached to the stage mount, the calibration standard remaining attached to the stage mount when the sample tray, base plate, and sample blocks are removed.

[0033] In some embodiments, placing the assembled sample tray, base plate, and sample blocks onto a stage mount in the scanning electron microscope includes placing a base plate having conical or hemispherical indentations onto a stage mount having hemispherical mating structures. And in some embodiments, placing the assembled sample tray, base plate, and sample blocks onto a stage mount includes providing at least one spring to provide electrical contact between the stage mount and the base plate.

[0034] In some embodiments, placing a base plate behind the sample blocks to maintain the sample blocks in the sample tray includes providing a spring to press at least one of the sample blocks into position at the sample tray holes. And in some embodiments, operating the charge particle beam system includes directing the electron beam to a sample block in an assembly including the sample block, sample tray, and base plate, the assembly supported on the stage mount by the weight of the assembly, without additional restraints.

[0035] In accordance with some embodiments of the invention, a sample holder system for a charged particle beam system having a chamber with a sample stage comprises a stage mount for being affixed to the stage of a charged particle beam system, the stage mount including three alignment structures, a base plate including three alignment structures, each alignment structure on the base plate structured to mate with a corresponding alignment structure on the stage mount, a sample tray configured to be removably attachable onto the base plate, the sample tray having multiple sample blocks positions, and a calibration standard holder secured to the stage mount and remaining on the stage mount as samples are changed in the charged particle beam system.

[0036] In some embodiments, the alignment structures or the corresponding alignment structures include three hemispherical portions or conical indentations. And in some embodiments, the alignment structures that mate with the three alignment structures on the stage mount comprise hemispherical portions and the three alignment structures on the base plate comprise conical or hemispherical indentations.

[0037] In some embodiments, the combined sample tray and base plate holder with sample blocks is maintained on the sample stage during charged particle beam operation by the weight of the sample holder, without additional restraint. And in some embodiments, the three mating structures on the stage mount are attached to the stage mount using fasteners.

[0038] In some embodiments, the sample holder system further comprises springs positioned on the base plate to press the sample blocks into the sample tray and to repeatably position the sample blocks relative to the sample tray. And in some embodiments, the sample holder system further comprises springs positioned on the stage mount to ensure electrical

contact between the stage mount and the base plate, the springs providing sufficient biasing force to provide electrical contact while still allowing the weight of the sample tray, base plate, and sample blocks to cause the aligning structures to fully engage.

[0039] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions, and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

[0040] We claim as follows:

CLAIMS

1. A sample holder system for a charged particle beam system having a sample chamber with a sample stage, comprising:

a stage mount for being affixed to the stage of a charged particle beam system, the stage mount including three alignment structures;

a base plate including three alignment structures, each alignment structure on the base plate structured to mate with a corresponding alignment structure on the stage mount, one of each mating alignment structures on the base plate or on stage mount including a hemispherical portion;

a sample tray configured to be removably attachable onto the base plate, the sample tray having multiple holes for positioning sample blocks;

a clamp holding the sample tray to the base plate; and

a calibration standard holder secured to the stage mount and remaining on the stage mount as samples are changed in the charged particle beam system.

2. The sample holder system of claim 1 in which the alignment structures that mate with the three hemispherical portions comprise conical indentations.

3. The sample holder system of claim 1 or claim 2 in which the alignment structures that mates with the three alignment structures on the stage mount comprise hemispherical portions and in which the three alignment structures on the base plate comprise conical or hemispherical indentations.

4. The sample holder system of any of the preceding claims in which the combined sample tray and base plate holder with sample blocks is maintained on the sample stage during charged particle beam operation by the weight of the sample holder, without additional restraint.

5. The sample holder system of any of the preceding claims in which the three mating structures on the stage mount are attached to the stage mount using fasteners.

6. The sample holder system of any of the preceding claims further comprising springs positioned on the base plate to press the sample blocks into the sample tray and to repeatably orient the sample blocks relative to the sample tray.

7. The sample holder system of any of the preceding claims further comprising springs positioned on the stage mount to ensure electrical contact between the stage mount and the base plate, the springs providing sufficient biasing force to provide electrical contact while still allowing the weight of the sample tray, base plate, and sample blocks to cause the aligning structures to fully engage.

8. A method for using a sample holder system for a scanning electron microscope for mineralogical sample comprising:

placing sample blocks into a sample tray, the sample tray having holes for positioning the sample blocks;

placing a base plate behind the sample blocks to maintain the sample blocks in the sample tray, the base plate including three alignment structures;

fastening the base plate to the sample tray without tools;

placing the assembled sample tray, base plate, and sample blocks onto a stage mount of the scanning electron microscope, the stage mount including alignment structures to mate with the alignment structures on the base plate, the alignment structures on the base plate mating with the alignment structures on the stage mount mating to position and orient the sample blocks in on the stage of the charged particle beam system; and

operating the charge particle beam system to analyze the sample in the sample blocks, the assembled sample tray, base plate, and sample blocks resting on the stage mount without being fastened to the stage mount.

9. The method of claim 8 further comprising measuring a calibration standard attached to the stage mount, the calibration standard remaining attached to the stage mount when the sample tray, base plate, and sample blocks are removed.

10. The method of claim 8 or claim 9 in which placing the assembled sample tray, base plate, and sample blocks onto a stage mount in the scanning electron microscope includes placing a base plate having conical or hemispherical indentations onto a stage mount having hemispherical mating structures.

11. The method of claims 8 - 10 in which placing a base plate behind the sample blocks to maintain the sample blocks in the sample tray includes providing a spring to press at least one of the sample blocks into position at the sample tray holes.

12. The method of claims 8 - 11 in which operating the charge particle beam system includes directing the electron beam to a sample block in an assembly including the sample block, sample tray, and base plate, the assembly supported on the stage mount by the weight of the assembly, without additional restraints.

13. The method of claims 8 - 12 in which placing the assembled sample tray, base plate, and sample blocks onto a stage mount includes providing at least one spring to provide electrical contact between the stage mount and the base plate.

14. A sample holder system for a charged particle beam system having a sample chamber with a sample stage, comprising:

a stage mount for being affixed to the stage of a charged particle beam system, the stage mount including three alignment structures;

a base plate including three alignment structures, each alignment structure on the base plate structured to mate with a corresponding alignment structure on the stage mount;

a sample tray configured to be removably attachable onto the base plate, the sample tray having multiple sample blocks positions; and

a calibration standard holder secured to the stage mount and remaining on the stage mount as samples are changed in the charged particle beam system.

15. The sample holder system of claim 14 in which the alignment structures or the corresponding alignment structures include three hemispherical portions or conical indentations.

16. The sample holder system of claim 14 or claim 15 in which the alignment structures that mates with the three alignment structures on the stage mount comprise hemispherical portions and in which the three alignment structures on the base plate comprise conical or hemispherical indentations.

17. The sample holder system of claims 14 - 16 in which the combined sample tray and base plate holder with sample blocks is maintained on the sample stage during charged particle beam operation by the weight of the sample holder, without additional restraint.

18. The sample holder system of claim 14 – 17 in which the three mating structures on the stage mount are attached to the stage mount using fasteners.

19. The sample holder system of claim 14 – 18 further comprising springs positioned on the base plate to press the sample blocks into the sample tray and to repeatably position the sample blocks relative to the sample tray.

20. The sample holder system of claim 14 – 19 further comprising springs positioned on the stage mount to ensure electrical contact between the stage mount and the base plate, the springs providing sufficient biasing force to provide electrical contact while still allowing the weight of the sample tray, base plate, and sample blocks to cause the aligning structures to fully engage.

AMENDED CLAIMS
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1. A sample holder system for a charged particle beam system having a sample chamber with a sample stage, comprising:

a stage mount for being affixed to the stage of a charged particle beam system, the stage mount including three alignment structures;

a base plate including three alignment structures, each alignment structure on the base plate structured to mate with a corresponding alignment structure on the stage mount, one of each mating alignment structures on the base plate or on stage mount including a hemispherical portion, the alignment structures determining the orientation, position and height of the base plate;

a sample tray configured to be removably attachable onto the base plate, the sample tray having multiple holes for positioning sample blocks;

a clamp holding the sample tray to the base plate; and

a calibration standard holder secured to the stage mount and remaining on the stage mount as samples are changed in the charged particle beam system.

2. The sample holder system of claim 1 in which the alignment structures that mate with the three hemispherical portions comprise conical indentations.

3. The sample holder system of claim 1 or claim 2 in which the alignment structures that mates with the three alignment structures on the stage mount comprise hemispherical portions and in which the three alignment structures on the base plate comprise conical or hemispherical indentations.

4. The sample holder system of any of the preceding claims in which the combined sample tray and base plate holder with sample blocks is maintained on the sample stage during charged particle beam operation by the weight of the sample holder, without additional restraint.

5. The sample holder system of any of the preceding claims in which the three mating structures on the stage mount are attached to the stage mount using fasteners.

6. The sample holder system of any of the preceding claims further comprising springs positioned on the base plate to press the sample blocks into the sample tray and to repeatably orient the sample blocks relative to the sample tray.

7. The sample holder system of any of the preceding claims further comprising springs positioned on the stage mount to ensure electrical contact between the stage mount

and the base plate, the springs providing sufficient biasing force to provide electrical contact while still allowing the weight of the sample tray, base plate, and sample blocks to cause the aligning structures to fully engage.

8. A method for using a sample holder system for a scanning electron microscope for mineralogical sample comprising:

placing sample blocks into a sample tray, the sample tray having holes for positioning the sample blocks;

placing a base plate behind the sample blocks to maintain the sample blocks in the sample tray, the base plate including three alignment structures;

fastening the base plate to the sample tray without tools;

placing the assembled sample tray, base plate, and sample blocks onto a stage mount of the scanning electron microscope, the stage mount including alignment structures to mate with the alignment structures on the base plate, the alignment structures on the base plate mating with the alignment structures on the stage mount mating to position and orient the sample blocks in on the stage of the charged particle beam system, the alignment structures determining the orientation, position and height of the base plate; and

operating the charge particle beam system to analyze the sample in the sample blocks, the assembled sample tray, base plate, and sample blocks resting on the stage mount without being fastened to the stage mount.

9. The method of claim 8 further comprising measuring a calibration standard attached to the stage mount, the calibration standard remaining attached to the stage mount when the sample tray, base plate, and sample blocks are removed.

10. The method of claim 8 or claim 9 in which placing the assembled sample tray, base plate, and sample blocks onto a stage mount in the scanning electron microscope includes placing a base plate having conical or hemispherical indentations onto a stage mount having hemispherical mating structures.

11. The method of any of claims 8 - 10 in which placing a base plate behind the sample blocks to maintain the sample blocks in the sample tray includes providing a spring to press at least one of the sample blocks into position at the sample tray holes.

12. The method of any of claims 8 - 11 in which operating the charge particle beam system includes directing the electron beam to a sample block in an assembly including the sample block, sample tray, and base plate, the assembly supported on the stage mount by the weight of the assembly, without additional restraints.

13. The method of any of claims 8 - 12 in which placing the assembled sample tray, base plate, and sample blocks onto a stage mount includes providing at least one spring to provide electrical contact between the stage mount and the base plate.

14. A sample holder system for a charged particle beam system having a sample chamber with a sample stage, comprising:

a stage mount for being affixed to the stage of a charged particle beam system, the stage mount including three alignment structures;

a base plate including three alignment structures, each alignment structure on the base plate structured to mate with a corresponding alignment structure on the stage mount, the alignment structures determining the orientation, position and height of the base plate;

a sample tray configured to be removably attachable onto the base plate, the sample tray having multiple sample blocks positions; and

a calibration standard holder secured to the stage mount and remaining on the stage mount as samples are changed in the charged particle beam system.

15. The sample holder system of claim 14 in which the alignment structures or the corresponding alignment structures include three hemispherical portions or conical indentations.

16. The sample holder system of claim 14 or claim 15 in which the alignment structures that mates with the three alignment structures on the stage mount comprise hemispherical portions and in which the three alignment structures on the base plate comprise conical or hemispherical indentations.

17. The sample holder system of any of claims 14 - 16 in which the combined sample tray and base plate holder with sample blocks is maintained on the sample stage during charged particle beam operation by the weight of the sample holder, without additional restraint.

18. The sample holder system of any of claims 14 – 17 in which the three mating structures on the stage mount are attached to the stage mount using fasteners.

19. The sample holder system of any of claims 14 – 18 further comprising springs positioned on the base plate to press the sample blocks into the sample tray and to repeatably position the sample blocks relative to the sample tray.

20. The sample holder system of any of claims 14 – 19 further comprising springs positioned on the stage mount to ensure electrical contact between the stage mount and the base plate, the springs providing sufficient biasing force to provide electrical contact while

still allowing the weight of the sample tray, base plate, and sample blocks to cause the aligning structures to fully engage.

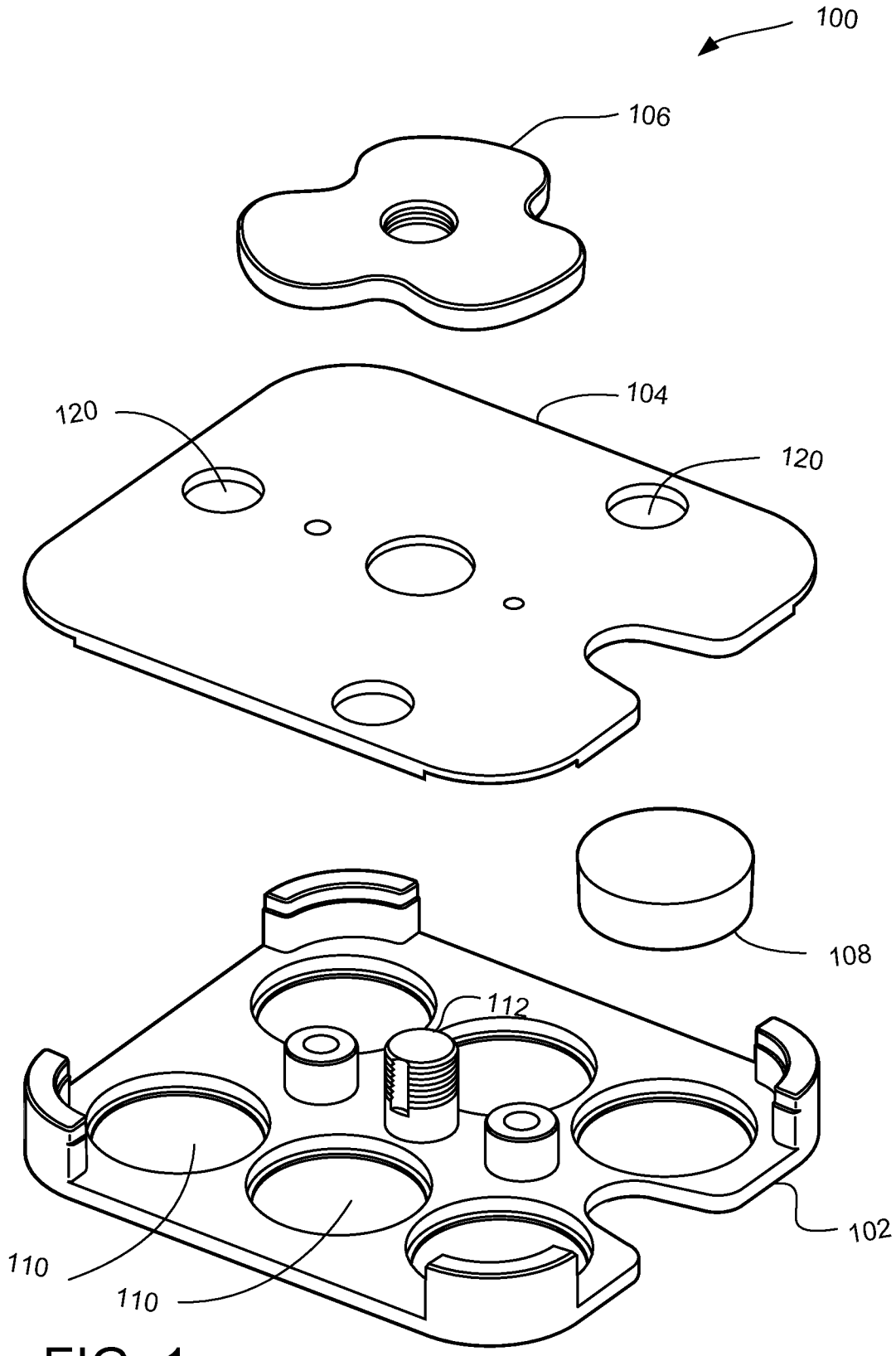


FIG. 1

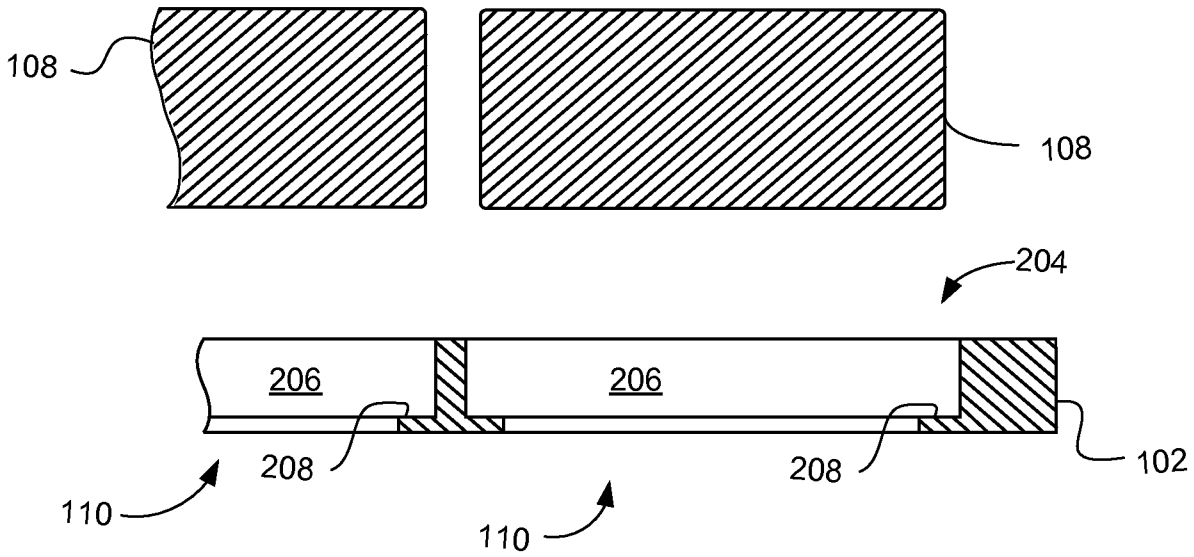


FIG. 2

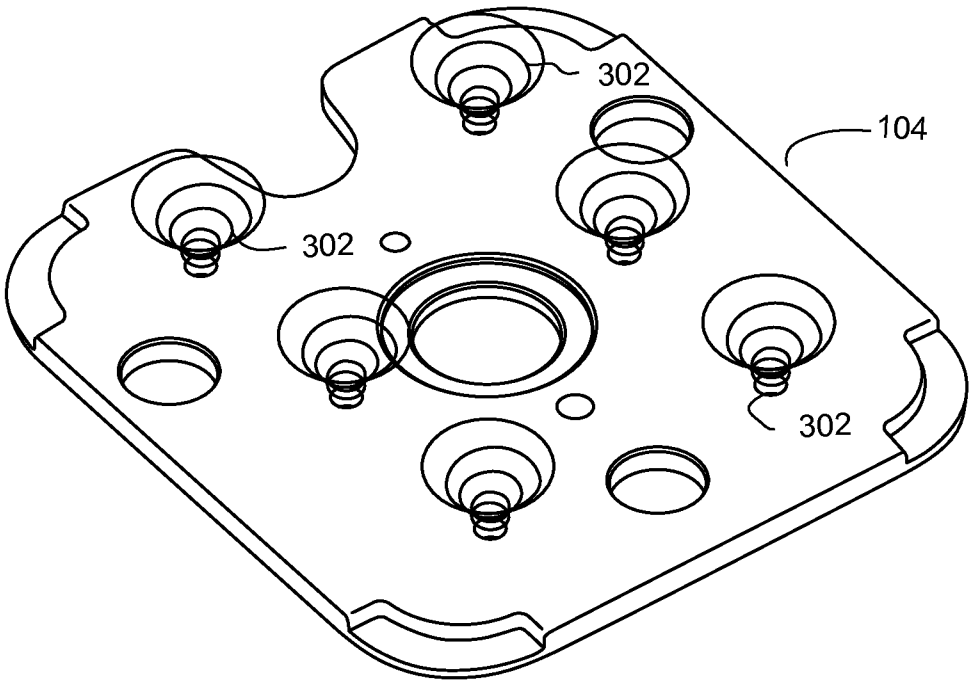


FIG. 3

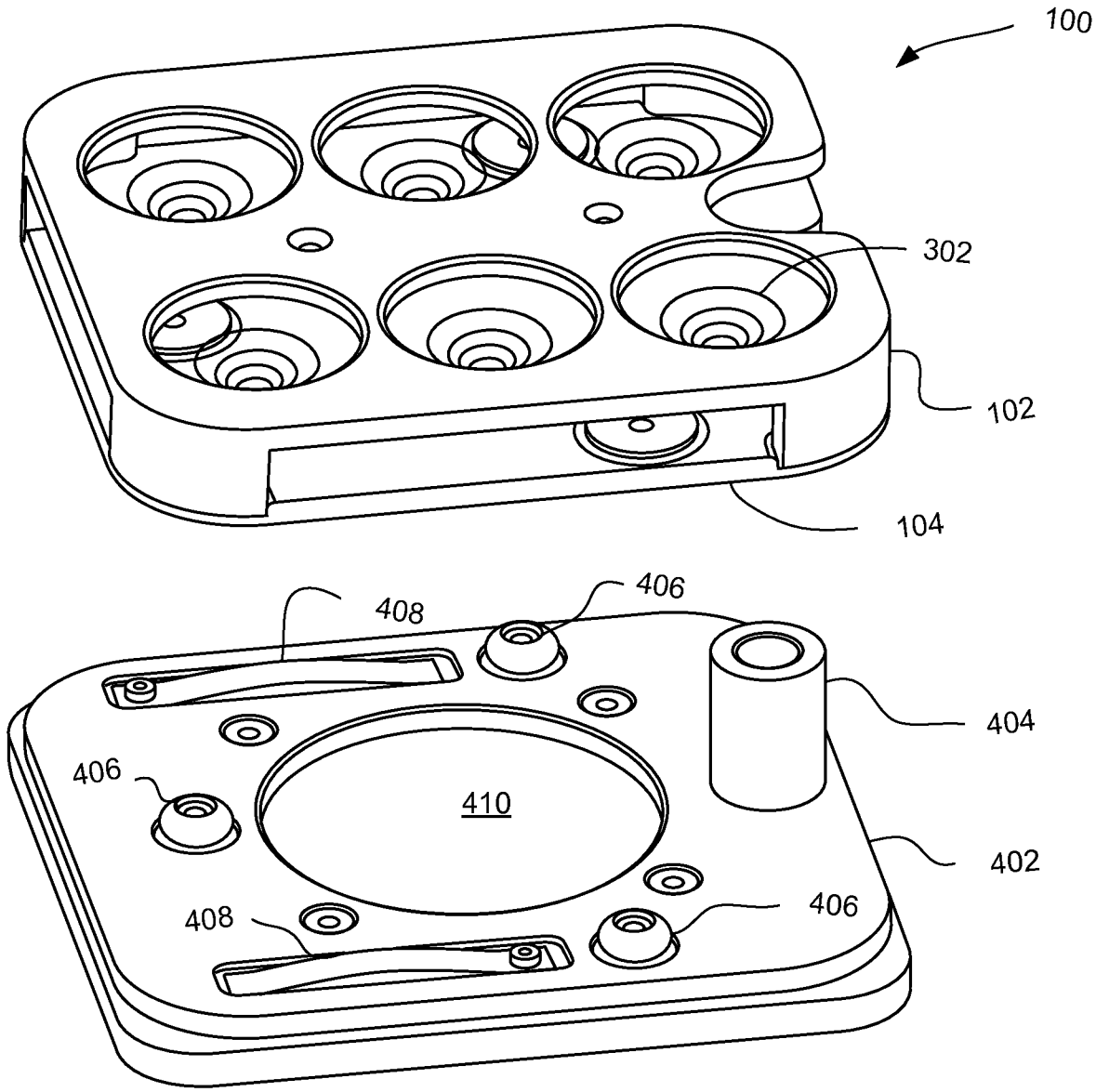


FIG. 4

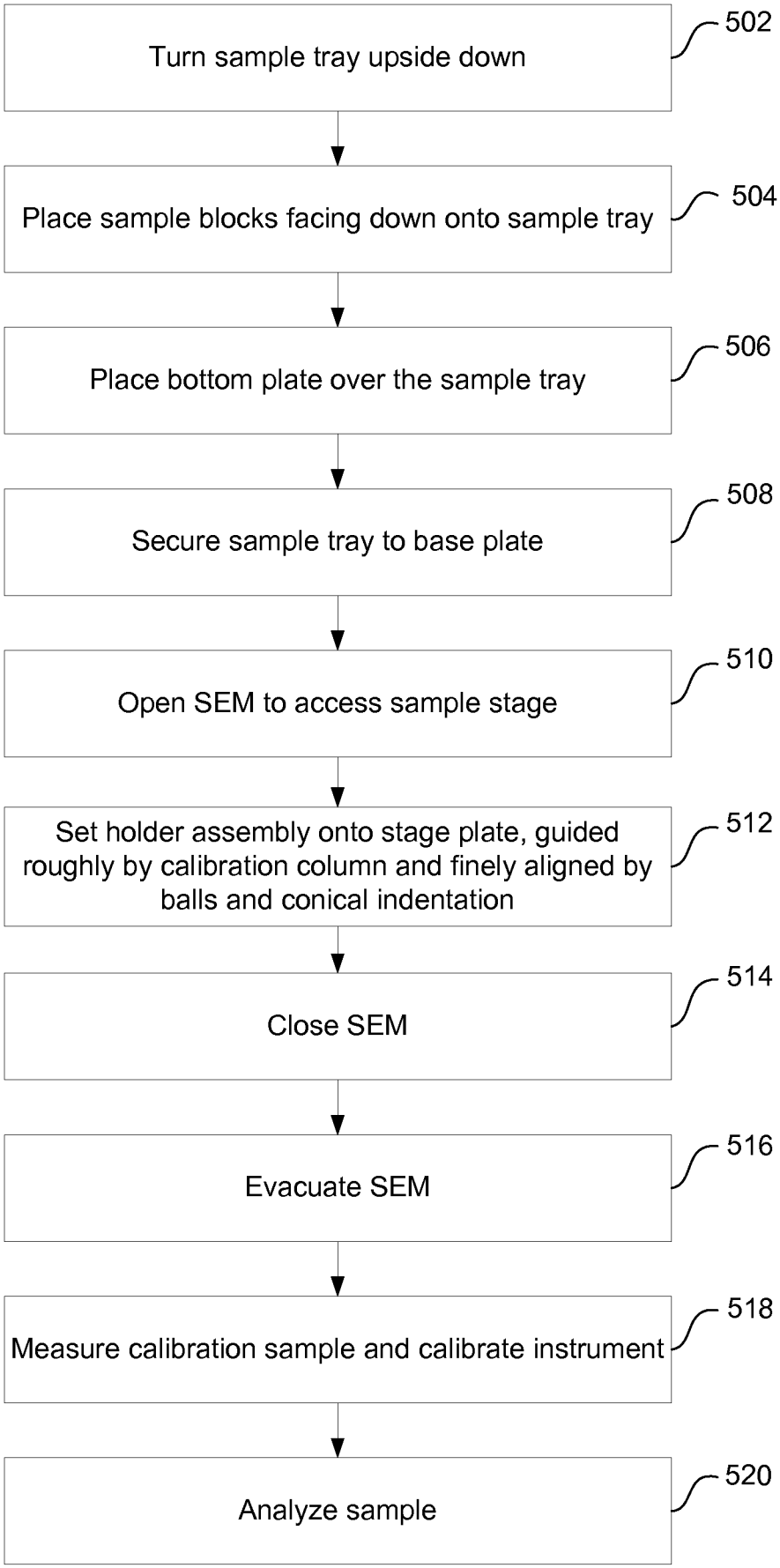

Turn sample tray upside down
502
Place sample blocks facing down onto sample tray
504
Place bottom plate over the sample tray
506
Secure sample tray to base plate
508
Open SEM to access sample stage
510
Set holder assembly onto stage plate, guided roughly by calibration column and finely aligned by balls and conical indentation
512
Close SEM
514
Evacuate SEM
516
Measure calibration sample and calibrate instrument
518
Analyze sample
520

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/061823

A. CLASSIFICATION OF SUBJECT MATTER

G01N 1/36(2006.01)i, G01N 23/225(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)

G01N 1/36; G01N 1/28; H01J 37/252; H01J 37/20; B23P 19/02

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: sample holder, SEM, electron beam and alignment

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2011-113640 A (FUJI ELECTRIC HOLDINGS CO., LTD.) 9 June 2011 See abstract; paragraphs [0021],[0022] and figures 3-4.	1-3,8-10,14-16
Y	US 4136429 A (BRANDES, WALTER B.) 30 January 1979 See abstract; column 4, lines 10-32 and figure 8.	1-3,8-10,14-16
A	JP 05-087707 A (NIKON CORP.) 6 April 1993 See abstract; paragraphs [0012],[0013] and figure 1.	1-3,8-10,14-16
A	JP 10-312763 A (HITACHI LTD. et al.) 24 November 1998 See abstract; paragraphs [0012],[0013] and figure 3.	1-3,8-10,14-16
A	JP 2001-006597 A (NEC ENG LTD.) 12 January 2001 See abstract and figure 1.	1-3,8-10,14-16

☐ 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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"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	Date of mailing of the international search report
28 JANUARY 2013 (28.01.2013)	**29 JANUARY 2013 (29.01.2013)**
Name and mailing address of the ISA/KR Facsimile No. 82-42-472-7140	Authorized officer AHN, Jaeyul Telephone No. 82-42-481-8525

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/061823

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-7,11-13,17-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/061823

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2011-113640 A	09.06.2011	None	
US 4136429 A	30.01.1979	None	
JP 05-087707 A	06.04.1993	None	
JP 10-312763 A	24.11.1998	None	
JP 2001-006597 A	12.01.2001	None	