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XPS sample holder, apparatus for X-ray photoelectron spectroscopy including the same and method for X-ray photoelectron spectroscopy using the same

Abstract

Provided is an XPS sample holder including: a holder body configured to provide an inner space; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member in a first direction that is a horizontal direction; an inner connection member disposed in the holder body and electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This U.S. non-provisional patent application claims priority under 35 U.S.C. § 119 of Korean Patent Application No. 10-2022-0131318, filed on Oct. 13, 2022, the entire contents of which are hereby incorporated by reference.

BACKGROUND

(2) The present disclosure herein relates to an XPS sample holder, an apparatus for X-ray photoelectron spectroscopy including the same, and a method for X-ray photoelectron spectroscopy using the same, and more particularly, to an XPS sample holder capable of performing a

spectroscopy measurement in a state in which a voltage is applied to a sample, an apparatus for X-ray photoelectron spectroscopy including the same, and a method for X-ray photoelectron spectroscopy using the same.

(3) X-ray photoelectron spectroscopy (XPS) may analyze a sample using a photoelectric effect. To this end, an apparatus for XPS may include an X-ray irradiation device. The X-ray irradiation device may irradiate a sample disposed on a holder with X-rays. When irradiated with the X-rays, photoelectrons may be emitted from the sample. Elements of the sample may be analyzed by detecting the photoelectrons emitted from the sample.

SUMMARY

(4) The present disclosure provides an XPS sample holder capable of analyzing a sample under a voltage applied environment, an apparatus for X-ray photoelectron spectroscopy including the same, and a method for X-ray photoelectron spectroscopy using the same.

(5) The present disclosure also provides an XPS sample holder capable of preventing distortion of measurement results caused by an electric field, an apparatus for X-ray photoelectron spectroscopy including the same, and a method for X-ray photoelectron spectroscopy using the same.

(6) The present disclosure also provides an XPS sample holder capable of providing a symmetric electric field, an apparatus for X-ray photoelectron spectroscopy including the same, and a method for X-ray photoelectron spectroscopy using the same.

(7) The object of the present invention is not limited to the aforesaid, but other objects not described herein will be clearly understood by those skilled in the art from descriptions below.

(8) An embodiment of the inventive concept provides an XPS sample holder including: a holder body configured to provide an inner space; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member in a first direction that is a horizontal direction; an inner connection member disposed in the holder body and electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member. Here, the first electrode part and the second electrode part are spaced apart from each other in the first direction.

(9) In an embodiment, the holder body may be electrically grounded.

(10) In an embodiment, the inner connection member may pass an axis of the holder body parallel to a second direction that is a vertical direction and have a shape symmetric based on a cross-section parallel to the first direction.

(11) In an embodiment, the inner connection member may include: an inner connection plate spreading in the horizontal direction; and an inner connection axis extending downward from the inner connection plate. Here, the inner connection axis may be disposed on the axis of the holder body, and the first voltage transmitting member may be electrically connected to the inner connection plate.

(12) In an embodiment, the XPS sample holder may further include an insulation plate disposed between the inner connection member and the holder body.

(13) In an embodiment, the holder body may include: an upper plate having the top surface; and a support member extending downward from the upper plate and surrounding the inner space at a side surface thereof.

(14) In an embodiment, the first electrode part may include: a first transmitting part having one end connected to the first voltage transmitting member and extending in the first direction; a first connection part extending from the other end of the first transmitting part in a horizontal direction crossing the first direction; and a plurality of first contact parts each extending from the first connection part in the first direction, and the second electrode part may include: a second transmitting part having one end connected to the second voltage transmitting member and

extending in the first direction; a second connection part extending from the other end of the second transmitting part in the horizontal direction crossing the first direction; and a plurality of second contact parts each extending from the second connection part in a direction opposite to the first direction. Here, each of the plurality of first contact parts may be arranged alternately with each of the plurality of second contact parts in the horizontal direction.
(15) In an embodiment, each of the first voltage transmitting member and the second voltage transmitting member may have a screw shape.
(16) In an embodiment of the inventive concept, an apparatus for X-ray photoelectron spectroscopy includes: an XPS sample holder; and an X-ray irradiation device configured to irradiate a sample on the XPS sample holder with X-rays. Here, the XPS sample holder includes: a holder body; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member; an inner connection member electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member. Also, the inner connection member includes: an inner connection plate spreading in a horizontal direction; and an inner connection axis extending downward from the inner connection plate, and the inner connection axis is disposed on an axis of the holder body.
(17) In an embodiment, the second voltage transmitting member may be electrically connected to the holder body, and the first voltage transmitting member may be electrically connected to the inner connection plate.
(18) In an embodiment, the holder body may include: an upper plate having the top surface; and a support member extending downward from the upper plate to define an inner space, and the inner connection member may be disposed in the inner space.
(19) In an embodiment, the XPS sample holder may further include an insulation plate disposed between the inner connection member and the holder body.
(20) In an embodiment, the insulation plate may be disposed in the inner space.
(21) In an embodiment, each of the first voltage transmitting member and the second voltage transmitting member may have a screw shape.
(22) In an embodiment, the apparatus may further include a detector configured to detect photoelectrons emitted from the sample on the XPS sample holder.
(23) In an embodiment of the inventive concept, a method for X-ray photoelectron spectroscopy includes: arranging a sample onto an XPS sample holder; applying a voltage to the sample by using the XPS sample holder; and irradiating the sample with X-rays, and the XPS sample holder includes: a holder body; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member; an inner connection member electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member. Here, the arranging of the sample onto the XPS sample holder includes arranging the sample onto the first electrode part and the second electrode part.
(24) In an embodiment, the applying of the voltage to the sample may be performed by the first electrode part and the second electrode part.
(25) In an embodiment, the second voltage transmitting member may be electrically connected to the holder body.
(26) In an embodiment, the inner connection member may include: an inner connection plate

spreading in a horizontal direction; and an inner connection axis extending downward from the inner connection plate, and the inner connection axis may be disposed on an axis of the holder body.
(27) In an embodiment, the method of claim may further include detecting photoelectrons emitted from the sample on the XPS sample holder.
(28) Particularities of other embodiments are included in the detailed description and drawings.

Description

BRIEF DESCRIPTION OF THE FIGURES
(1) The accompanying drawings are included to provide a further understanding of the inventive concept, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the inventive concept and, together with the description, serve to explain principles of the inventive concept. In the drawings:
(2) FIG. **1** is a schematic view illustrating an apparatus for X-ray photoelectron spectroscopy according to embodiments of the inventive concept;
(3) FIG. **2** is a perspective view illustrating a XPS sample holder according to embodiments of the inventive concept;
(4) FIG. **3** is an exploded perspective view illustrating the XPS sample holder according to embodiments of the inventive concept;
(5) FIG. **4** is a partially-cut perspective view illustrating the XPS sample holder according to embodiments of the inventive concept;
(6) FIG. **5** is a cross-sectional view illustrating the XPS sample holder according to embodiments of the inventive concept;
(7) FIG. **6** is a plan view illustrating a portion of the XPS sample holder according to embodiments of the inventive concept;
(8) FIG. **7** is a flowchart representing a method for X-ray photoelectron spectroscopy according to embodiments of the inventive concept; and
(9) FIG. **8**, FIG. **9**, FIG. **10**, and FIG. **11** are views sequentially illustrating the method for X-ray photoelectron spectroscopy according to the flowchart in FIG. **7**.
DETAILED DESCRIPTION
(10) Preferred embodiments of the inventive concept will be described with reference to the accompanying drawings so as to sufficiently understand constitutions and effects of embodiments of the inventive concept. The technical ideas of the inventive concept may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the present invention to those skilled in the art. Further, the present invention is only defined by scopes of claims.
(11) Like reference numerals refer to like elements throughout. The embodiment in the detailed description will be described with cross-sectional views and/or plan views as ideal exemplary views of the inventive concept. Also, in the figures, the dimensions of layers and regions are exaggerated for clarity of illustration. Areas exemplified in the drawings have general properties, and are used to illustrate a specific shape of a semiconductor package region. Thus, this should not be construed as limited to the scope of the present invention. Also, although various terms are used to describe various components in various embodiments of the inventive concept, the component are not limited to these terms. These terms are only used to distinguish one component from another component. Embodiments described and exemplified herein include complementary embodiments thereof.
(12) In the specification, the technical terms are used only for explaining a specific exemplary

embodiment while not limiting the present invention. In the specification, the terms of a singular form may include plural forms unless referred to the contrary. Also, the meaning of “include,” “comprise,” “including,” or “comprising,” specifies a property, a region, a fixed number, a step, a process, an element and/or a component but does not exclude other properties, regions, fixed numbers, steps, processes, elements and/or components.

(13) Hereinafter, preferred embodiments of the inventive concept will be described in detail with reference to the attached drawings.

(14) FIG. **1** is a schematic view illustrating an apparatus for X-ray photoelectron spectroscopy according to embodiments of the inventive concept.

(15) Hereinafter, D**1** may be referred to as a first direction, D**2** crossing the first direction D**1** may be referred to as a second direction, and D**3** crossing each of the first direction D**1** and the second direction D**2** may be referred to as a third direction. Each of the first direction D**1** and the second direction D**2** may be referred to as a horizontal direction. Also, the second direction D**2** may be referred to as a vertical direction.

(16) Referring to FIG. **1**, an apparatus for X-ray photoelectron spectroscopy (hereinafter, referred to as an X-ray photoelectron spectroscopy apparatus) may be provided. The X-ray photoelectron spectroscopy apparatus may analyze a sample by using a photoelectric effect. More specifically, the X-ray photoelectron spectroscopy apparatus may irradiate a sample with X-rays to detect photoelectrons emitted from the sample. To this end, the X-ray photoelectron spectroscopy apparatus may include an XPS sample holder A, an X-ray irradiation device X, and a detector D.

(17) The XPS sample holder A may support the sample. That is, a method for X-ray photoelectron spectroscopy (hereinafter, referred to as an X-ray photoelectron spectroscopy method) may be implemented in a state in which the sample is disposed on the XPS sample holder A. The XPS sample holder A may apply a voltage to the sample. Thus, the sample may be analyzed under a voltage applied environment. To this end, the XPS sample holder A may include a holder body **1**, a first voltage transmitting member **31**, and a second voltage transmitting member **33**. The holder body **1** may support the sample. The first voltage transmitting member **31** and the second voltage transmitting member **33** may apply a voltage to the sample. A detailed description thereof will be described later.

(18) The X-ray irradiation device X may be disposed above the XPS sample holder A. For example, the X-ray irradiation device X may be spaced upward from the XPS sample holder A. The X-ray irradiation device X may irradiate the XPS sample holder A with X-rays. More specifically, the X-ray irradiation device X may irradiate the sample disposed on the XPS sample holder A with X-rays. To this end, the X-ray irradiation device X may include various configurations capable of generating and irradiating the X-rays.

(19) The detector D may be disposed above the XPS sample holder A. For example, the detector D may be spaced upward from the XPS sample holder A. The detector D may be spaced apart from the X-ray irradiation device X in the horizontal direction. The detector D may detect electrons emitted from the sample. More specifically, the detector D may detect photoelectrons emitted from the sample irradiated with the X-rays. The detector D may obtain elements of the sample by analyzing information of the photoelectrons detected by the detector D. To this end, the detector D may be connected to a separate control unit such as a computer.

(20) FIG. **2** is a perspective view illustrating the XPS sample holder according to the embodiments of the inventive concept, FIG. **3** is an exploded perspective view illustrating the XPS sample holder according to the embodiments of the inventive concept, FIG. **4** is a partially-cut perspective view illustrating the XPS sample holder according to the embodiments of the inventive concept, and FIG. **5** is a cross-sectional view illustrating the XPS sample holder according to the embodiments of the inventive concept.

(21) Referring to FIGS. **2** to **5**, the XPS sample holder A may include the holder body **1**, the first voltage transmitting member **31**, the second voltage transmitting member **33**, a first ring **21**, a

second ring **23**, an inner connection member **5**, an insulation plate **7**, and a voltage applying part **9**.
(22) The holder body **1** may provide an inner space **1***h*. The inner connection member **5** or the like may be disposed in the inner space **1***h* of the holder body **1**. The holder body **1** may include a conductive material. For example, the holder body **1** may include metal. The holder body **1** may be electrically grounded. The holder body **1** may have an axis AX parallel to the second direction D**2**. The holder body **1** may include an upper plate **11** and a support member **13**. The upper plate **11** may spread in the horizontal direction. The upper plate **11** may have a circular plate shape. The sample may be disposed on a top surface **1***u* of the upper plate **11**. The upper plate **11** may have a first upper hole **1***ha* and a second upper hole **1***hb*. A portion of the first voltage transmitting member **31** may be inserted into the first upper hole **1***ha*. A portion of the second voltage transmitting member **33** may be inserted into the second upper hole **1***hb*. The support member **13** may extend downward from the upper plate **11**. The support member **13** may have a hollow cylindrical shape. More specifically, the support member **13** may have a shape of a rotating body that rotates around an axis AX. The inner space **1***h* may be defined by an inner surface of the support member **13**. More specifically, the inner space **1***h* may be defined by the inner surface of the support member **13** and a bottom surface of the upper plate **11**.
(23) The first voltage transmitting member **31** may pass through the top surface **1***u* of the holder body **1** in the vertical direction. A portion of the first voltage transmitting member **31** may be disposed on the top surface **1***u* of the holder body **1**. As the first voltage transmitting member **31** passes through the upper plate **11** in the vertical direction, a portion of the first voltage transmitting member **31** may be disposed in the inner space **1***h*. The first voltage transmitting member **31** may be electrically connected to the inner connection member **5**. For example, a bottom surface of the first voltage transmitting member **31** may contact the inner connection member **5**. Alternatively, as the first voltage transmitting member **31** is inserted to the inner connection member **5**, the first voltage transmitting member **31** may contact the inner connection member **5**. Alternatively, as the first voltage transmitting member **31** is inserted to the inner connection member **5**, the first voltage transmitting member **31** may contact the inner connection member **5**. The first voltage transmitting member **31** may be electrically insulated from the holder body **1**. To this end, the first voltage transmitting member **31** may not contact the holder body **1**. Alternatively, the first voltage transmitting member **31** may be covered by an insulating material in a portion in which the first voltage transmitting member **31** contacts the holder body **1**. Although the first voltage transmitting member **31** may have a screw shape, the embodiment of the inventive concept is not limited thereto.
(24) The second voltage transmitting member **33** may be spaced apart from the first voltage transmitting member **31** in the horizontal direction. For example, the second voltage transmitting member **33** may be spaced apart from the first voltage transmitting member **31** in the first direction D**1**. The second voltage transmitting member **33** may pass through the top surface **1***u* of the holder body **1** in the vertical direction. A portion of the second voltage transmitting member **33** may be disposed on the top surface **1***u* of the holder body **1**. As the second voltage transmitting member **33** passes through the upper plate **11** in the vertical direction, a portion of the second voltage transmitting member **33** may be disposed in the inner space **1***h*. The second voltage transmitting member **33** may be electrically connected to the holder body **1**. For example, a side surface of the second voltage transmitting member **33** may contact the holder body **1**. The second voltage transmitting member **33** may be electrically insulated from the inner connection member **5**. To this end, the second voltage transmitting member **33** may not contact the inner connection member **5**. Alternatively, the second voltage transmitting member **33** may be covered by an insulating material in a portion in which the second voltage transmitting member **33** contacts the inner connection member **5**. Since the second voltage transmitting member **33** is not electrically connected to the inner connection member **5**, the second voltage transmitting member **33** may not be electrically connected to the first voltage transmitting member **31**. Although the second voltage transmitting

member **33** may have a screw shape, the embodiment of the inventive concept is not limited thereto.

(25) The first ring **21** may be disposed on the top surface **1***u* of the holder body **1**. The first ring **21** may be connected to the first voltage transmitting member **31**. The first ring **21** may include a conductive material. The first voltage transmitting member **31** may be electrically connected to a portion of the voltage applying part **9** by the first ring **21**.

(26) The second ring **23** may be disposed on the top surface **1***u* of the holder body **1**. The second ring **23** may be connected to the second voltage transmitting member **33**. The second ring **23** may include a conductive material. The second voltage transmitting member **33** may be electrically connected to another portion of the voltage applying part **9** by the second ring **23**.

(27) The inner connection member **5** may be disposed in the holder body **1**. More specifically, the inner connection member **5** may be disposed in the inner space **1***h*. The inner connection member **5** may include a conductive material. For example, the inner connection member **5** may include metal. The inner connection member **5** may have a symmetric shape. More specifically, the inner connection member **5** may have a shape symmetric with respect to a cross-section passing the axis AX and parallel to the second direction D**2**. The inner connection member **5** may include an inner connection plate **51**, a lower plate **53**, and an inner connection axis **55**.

(28) The inner connection plate **51** may spread in the horizontal direction. The inner connection plate **51** may have a circular plate shape. The inner connection plate **51** may be electrically connected to the first voltage transmitting member **31**. The inner connection plate **51** may have a first hole **51***ha*, a second hole **51***hb*, and a third hole **51***hc*. The first hole **51***ha* may be disposed below the first voltage transmitting member **31**. The first voltage transmitting member **31** and the inner connection plate **51** may contact each other on the first hole **51***ha*. The first hole **51***ha* may have a diameter less than that of the first voltage transmitting member **31**. However, the embodiment of the inventive concept is not limited thereto. That is, the first voltage transmitting member **31** may be inserted to the first hole **51***ha*. The second hole **51***hb* may be disposed below the second voltage transmitting member **33**. The second hole **51***hb* may have a diameter greater than that of the second voltage transmitting member **33**. That is, the second voltage transmitting member **33** may be inserted to the second hole **51***hb*. Although the second voltage transmitting member **33** is inserted to the second hole **51***hb* because the second hole **51***hb* has the diameter greater than that of the second voltage transmitting member **33**, the second voltage transmitting member **33** and the inner connection plate **51** may not contact each other. However, the embodiment of the inventive concept is not limited thereto. For example, the second voltage transmitting member **33** may not be inserted to the second hole **51***hb*. A coupling member **41** may be inserted to the third hole **51***hc*. The inner connection member **5**, the insulation plate **7**, and the holder body **1** may be coupled to each other by the coupling member **41**. The third hole **51***hc* may be provided in plurality. A plurality of third holes **51***hc* may be spaced apart from each other in a circumferential direction.

(29) The lower plate **53** may be coupled to a bottom surface of the inner connection plate **51**. The lower plate **53** may have a circular plate shape.

(30) The inner connection axis **55** may extend downward from the inner connection plate **51**. More specifically, the inner connection axis **55** may extend downward from a bottom surface of the lower plate **53**. The inner connection axis **55** may be disposed on the axis AX.

(31) Although the inner connection plate **51**, the lower plate **53**, and the inner connection axis **55** may be integrated with each other, the embodiment of the inventive concept is not limited thereto.

(32) The inner connection member **5** may be connected to a voltage supply unit VS. For example, the inner connection axis **55** may be electrically connected to the voltage supply unit VS. A voltage supplied from the voltage supply unit VS may be transmitted to the voltage applying part **9** through the inner connection member **5** and the first transmitting member **31**.

(33) The insulation plate **7** may be disposed between the inner connection member and the holder

body **1**. The insulation plate **7** may be disposed on a bottom surface of the upper plate **11**. The insulation plate **7** may include an insulating material. For example, the insulation plate **7** may include ceramic. The holder body **1** and the inner connection member **5** may be electrically insulated from each other by the insulation plate **7**. The insulation plate **7** may have a circular plate shape. The insulation plate **7** may have a first insulation hole **7***ha* and a second insulation hole **7***hb*. The first insulation hole **7***ha* may be disposed on the first hole **51***ha*. The first voltage transmission member **31** may be electrically connected to the inner connection member **51** through the first insulation hole **7***ha*. The second insulation hole **7***hb* may be disposed on the second hole **51***hb*.

(34) The voltage applying part **9** may be disposed on the holder body **1**. More specifically, the voltage applying part **9** may be disposed on the top surface **1***u* of the holder body **1**. A portion of the voltage applying part **9** may be electrically connected to the first voltage transmitting member **31**. Another portion of the voltage applying part **9** may be electrically connected to the second voltage transmitting member **33**. The sample may be disposed on the voltage applying part **9**. A detailed description of the voltage applying part **9** will be described later with reference to FIG. **6**.

(35) FIG. **6** is a plan view illustrating a portion of the XPS sample holder according to embodiments of the inventive concept.

(36) Referring to FIG. **6**, the voltage applying part **9** may include a base plate **91**, a first electrode part **93**, and a second electrode part **95**.

(37) The base plate **91** may be disposed on the top surface **1***u* of the holder body **1** (refer to FIG. **2**). The base plate **91** may include an insulating material. The first electrode part **93** may be disposed on the base plate **91**. The first electrode part **93** may be electrically connected to the first voltage transmitting member **31** (refer to FIG. **2**). For example, the first electrode part **93** may be electrically connected to the first voltage transmitting member **31** through the first ring **21**. The first electrode part **93** may include a conductive material. For example, the first electrode part **93** may include metal. The first electrode part **93** may include a first transmitting part **931**, a first connection part **933**, and a first contact part **935**. The first transmitting part **931** may have one end connected to the first voltage transmitting member **31**. The first transmitting part **931** may extend in the first direction D**1**. The first connection part **933** may extend from the other end of the first transmitting part **931** in the third direction D**3**. The first contact part **935** may extend from the first connection part **933** in the first direction D**1**. The first contact part **935** may be provided in plurality. A plurality of first contact parts **935** may be spaced apart from each other in the third direction D**3**.

(38) The second electrode part **95** may be disposed on the base plate **91**. The second electrode part **95** may be electrically connected to the second voltage transmitting member **33** (refer to FIG. **2**). For example, the second electrode part **95** may be electrically connected to the second voltage transmitting member **33** through the second ring **23**. The second electrode part **95** may include a conductive material. For example, the second electrode part **95** may include metal. The second electrode part **95** may include a second transmitting part **951**, a second connection part **953**, and a second contact part **955**. The second transmitting part **951** may have one end connected to the first voltage transmitting member **33**. The second transmitting part **951** may extend in the first direction D**1**. The second connection part **953** may extend from the other end of the second transmitting part **931** in the third direction D**3**. The second contact part **955** may extend from the second connection part **953** in the first direction D**1**. The second contact part **955** may be provided in plurality. A plurality of second contact parts **955** may be spaced apart from each other in the third direction D**3**. As illustrated in FIG. **6**, the plurality of first contact parts **935** and the plurality of second contact parts **955** may be arranged alternately with each other in the third direction D**3**. Each of the plurality of first contact parts **935** may be spaced apart from each of the plurality of second contact parts **955**. Thus, each of the plurality of first contact parts **935** may be electrically insulated from each of the plurality of second contact parts **955**.

(39) FIG. **7** is a flowchart representing a method for X-ray photoelectron spectroscopy according to

embodiments of the inventive concept.
(40) Referring to FIG. **7**, a method S for X-ray photoelectron spectroscopy (hereinafter, referred to as an X-ray photoelectron spectroscopy method S) may be provided. The X-ray photoelectron spectroscopy method S may be a method for analyzing a sample by using the X-ray photoelectron spectroscopy apparatus described with reference to FIGS. **1** to **6**. The X-ray photoelectron spectroscopy method S may include a process **51** of arranging a sample onto an XPS sample holder, a process S**2** of applying a voltage to the sample, a process S**3** of irradiating the sample with X-rays, and a process S**4** of detecting photoelectrons.
(41) Hereinafter, the X-ray photoelectron spectroscopy method S will be described in detail with reference to FIGS. **8** to **11**.
(42) FIGS. **8** to **11** are views sequentially illustrating the X-ray photoelectron spectroscopy method according to the flowchart in FIG. **7**.
(43) Referring to FIGS. **8**, **9**, **10**, and **7**, the process **51** of arranging the sample onto the XPS sample holder may include a process of arranging a sample SP onto a voltage applying part **9**. The sample SP may be an object to be analyzed by using the X-ray photoelectron spectroscopy method. The sample SP may have one portion disposed on a first electrode part **93**. Thus, the sample SP may have the one portion electrically connected to the first electrode part **93**. The sample SP may have another portion disposed on a second electrode part **95**. Thus, the sample SP may have the another portion electrically connected to the second electrode part **95**.
(44) Referring to FIGS. **9**, **10**, and **7**, the process S**2** of applying a voltage to the sample may be performed by an XPS sample holder A. That is, the process S**2** of applying a voltage to the sample may be performed by the first electrode part **93** and the second electrode part **95**. More specifically, a voltage may be applied to one side of the sample SP from the voltage supply unit VS through an inner connection member **5**, a first voltage transmitting member **31**, and the first electrode part **93**. Thus, the sample SP may be disposed under a voltage applied environment.
(45) Referring to FIGS. **11** and **7**, the process S**3** of irradiating the sample with X-rays may include a process of irradiating the sample SP on the XPS sample holder A with X-rays L**1**. When the sample SP is irradiated with the X-rays L**1**, photoelectrons may be emitted from the sample SP by a photoelectric effect.
(46) The process S**4** of detecting photoelectrons may include a process of detecting photoelectrons L**2** emitted from the sample SP by a detector D. That is, when the photoelectrons L**2** are emitted from the sample SP by the X-rays L**1**, the detector D may detect the emitted photoelectrons L**2**. The detector D may perform analysis on the sample SP by using detected information.
(47) According to the XPS sample holder, the X-ray photoelectron spectroscopy apparatus including the same, and the X-ray photoelectron spectroscopy method using the same, the sample may be analyzed under the voltage applied environment. That is, characteristics of the sample may be analyzed by using the XPS sample holder in a state in which a voltage is applied to the sample. Thus, when a voltage is applied, the sample may be real-time analyzed.
(48) According to the XPS sample holder, the X-ray photoelectron spectroscopy apparatus including the same, and the X-ray photoelectron spectroscopy method using the same, a symmetric electric field may be provided. More specifically, since each of the holder body and/or the inner connection member has a symmetric shape, Also, since the electric field is blocked by the holder body, distortion of the electric field may be prevented from being generated at the outside of the holder body. Thus, distortion of measurement results caused by the electric field may be prevented. That is, even when a voltage is applied to the sample, exact measurement may be performed.
(49) According to the XPS sample holder, the apparatus for X-ray photoelectron spectroscopy including the same, and the method for X-ray photoelectron spectroscopy using the same, the sample may be analyzed under the voltage applied environment.
(50) According to the XPS sample holder, the apparatus for X-ray photoelectron spectroscopy including the same, and the method for X-ray photoelectron spectroscopy using the same, the

distortion of the measurement results caused by the electric field may be prevented.
(51) According to the XPS sample holder, the apparatus for X-ray photoelectron spectroscopy including the same, and the method for X-ray photoelectron spectroscopy using the same, the symmetric electric field may be provided.
(52) The effects of the present invention are not limited to the aforementioned effects, but other objects not described herein will be clearly understood by those skilled in the art from descriptions below.
(53) Although the embodiments of the present invention have been described, it is understood that the present invention should not be limited to these embodiments but various changes and modifications can be made by one ordinary skilled in the art within the spirit and scope of the present invention as hereinafter claimed. Thus, the above-disclosed embodiments are to be considered illustrative and not restrictive.

Claims

1. An X-ray photoelectron spectroscopy (XPS) sample holder comprising: a holder body configured to provide an inner space; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member in a first direction that is a horizontal direction; an inner connection member disposed in the holder body and electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member, wherein the first electrode part and the second electrode part are spaced apart from each other in the first direction.
2. The XPS sample holder of claim 1, wherein the holder body is electrically grounded.
3. The XPS sample holder of claim 1, wherein the inner connection member passes an axis of the holder body parallel to a second direction that is a vertical direction and has a shape symmetric based on a cross-section parallel to the first direction.
4. The XPS sample holder of claim 3, wherein the inner connection member comprises: an inner connection plate spreading in the horizontal direction; and an inner connection axis extending downward from the inner connection plate, wherein the inner connection axis is disposed on the axis of the holder body, and the first voltage transmitting member is electrically connected to the inner connection plate.
5. The XPS sample holder of claim 1, further comprising an insulation plate disposed between the inner connection member and the holder body.
6. The XPS sample holder of claim 1, wherein the holder body comprises: an upper plate having the top surface; and a support member extending downward from the upper plate and surrounding the inner space at a side surface thereof.
7. The XPS sample holder of claim 1, wherein the first electrode part comprises: a first transmitting part having one end connected to the first voltage transmitting member and extending in the first direction; a first connection part extending from the other end of the first transmitting part in a horizontal direction crossing the first direction; and a plurality of first contact parts each extending from the first connection part in the first direction, and the second electrode part comprises: a second transmitting part having one end connected to the second voltage transmitting member and extending in the first direction; a second connection part extending from the other end of the second transmitting part in the horizontal direction crossing the first direction; and a plurality of second contact parts each extending from the second connection part in a direction opposite to the first direction, wherein each of the plurality of first contact parts is arranged alternately with each of the plurality of second contact parts in the horizontal direction.

8. The XPS sample holder of claim 1, wherein each of the first voltage transmitting member and the second voltage transmitting member has a screw shape.
9. An apparatus for X-ray photoelectron spectroscopy (XPS), comprising: an XPS sample holder; and an X-ray irradiation device configured to irradiate a sample on the XPS sample holder with X-rays, wherein the XPS sample holder comprises: a holder body; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member; an inner connection member electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member, wherein the inner connection member comprises: an inner connection plate spreading in a horizontal direction; and an inner connection axis extending downward from the inner connection plate, wherein the inner connection axis is disposed on an axis of the holder body.
10. The apparatus of claim 9, wherein the second voltage transmitting member is electrically connected to the holder body, and the first voltage transmitting member is electrically connected to the inner connection plate.
11. The apparatus of claim 9, wherein the holder body comprises: an upper plate having the top surface; and a support member extending downward from the upper plate to define an inner space, wherein the inner connection member is disposed in the inner space.
12. The apparatus of claim 11, wherein the XPS sample holder further comprises an insulation plate disposed between the inner connection member and the holder body.
13. The apparatus of claim 12, wherein the insulation plate is disposed in the inner space.
14. The apparatus of claim 9, wherein each of the first voltage transmitting member and the second voltage transmitting member has a screw shape.
15. The apparatus of claim 9, further comprising a detector configured to detect photoelectrons emitted from the sample on the XPS sample holder.
16. A method for X-ray photoelectron spectroscopy (XPS), comprising: arranging a sample onto an XPS sample holder; applying a voltage to the sample by using the XPS sample holder; and irradiating the sample with X-rays, wherein the XPS sample holder comprises: a holder body; a first voltage transmitting member that passes through a top surface of the holder body in a vertical direction; a second voltage transmitting member that passes through the top surface of the holder body in the vertical direction and is spaced apart from the first voltage transmitting member; an inner connection member electrically connected to the first voltage transmitting member; a first electrode part disposed on the top surface of the holder body and connected to the first voltage transmitting member; and a second electrode part disposed on the top surface of the holder body and connected to the second voltage transmitting member, wherein the arranging of the sample onto the XPS sample holder comprises arranging the sample onto the first electrode part and the second electrode part.
17. The method of claim 16, wherein the applying of the voltage to the sample is performed by the first electrode part and the second electrode part.
18. The method of claim 16, wherein the second voltage transmitting member is electrically connected to the holder body.
19. The method of claim 16, wherein the inner connection member comprises: an inner connection plate spreading in a horizontal direction; and an inner connection axis extending downward from the inner connection plate, wherein the inner connection axis is disposed on an axis of the holder body.
20. The method of claim 16, further comprising detecting photoelectrons emitted from the sample on the XPS sample holder.