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Coil component and method of manufacturing the same

Abstract

A coil component includes a main body made of a magnetic material, a linear inductor wiring conductor arranged in the main body, an electrically insulating pedestal having a top surface extending along the inductor wiring conductor in the main body and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface, and a conductive seed layer provided over an entire region of at least a region sandwiched between the top surface of the pedestal and the inductor wiring conductor. When a width dimension of a surface of the inductor wiring conductor in contact with the seed layer is defined as a first width dimension and a width dimension of the seed layer is defined as a second width dimension, the second width dimension is larger than the first width dimension.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2017/0032882	12/2016	Yang	N/A	H01F 27/2804
2019/0244743	12/2018	Hirai	N/A	H01F 41/12
2020/0098506	12/2019	Hamada	N/A	H01F 27/32

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
103474367	12/2012	CN	H01L 24/11
2014-032978	12/2013	JP	N/A
2017199718	12/2016	JP	N/A
19990066108	12/1998	KR	N/A

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) This application claims benefit of priority to Japanese Patent Application No. 2021-054434 filed Mar. 27, 2021, the entire content of which is incorporated herein by reference.

BACKGROUND

Technical Field

(2) The present disclosure relates to a coil component and a method of manufacturing the same, and more particularly to a coil component in which a linear inductor wiring conductor is built in a main body made of a magnetic material and a method of manufacturing the same.

Background Art

(3) Japanese Unexamined Patent Application Publication No. 2014-32978 describes a coil component including an insulating substrate, a build-up portion provided on the insulating substrate, a seed layer formed on the build-up portion by electroless copper plating or the like, an

inductor wiring conductor formed on the seed layer by electrolytic copper plating or the like, and an insulating resin film coating that coats the inductor wiring conductor.

SUMMARY

(4) In the above-described coil component, since the seed layer is for supplying electric charge when the inductor wiring conductor is formed by electrolytic plating, the seed layer is not particularly required after the inductor wiring conductor is formed. Also, since the seed layer is made of an electrically conductive material, this may lead to an undesired electrical short circuit. Therefore, after the inductor wiring conductor is formed, an unnecessary portion of the seed layer, that is, a portion of the seed layer exposed from the inductor wiring conductor is removed.

(5) Wet etching is typically applied to remove the unnecessary portion of the seed layer. However, the wet etching affects not only the seed layer but also the inductor wiring conductor. As such, the inductor wiring conductor is thinned, as a result, which causes such problems that the resistance value of the inductor wiring conductor is increased, and a close contact force between the inductor wiring conductor and a member forming a base thereof is decreased. This problem becomes more prominent particularly when the inductor wiring conductor and the seed layer are made of materials having the same main component, such as when the inductor wiring conductor is made of copper and the seed layer is made of copper.

(6) In view of the above, the present disclosure provides a structure of a coil component by which problems resulted from thinning of the inductor wiring conductor can be less likely to occur even when an unnecessary portion of the seed layer is removed, such as an increase in resistance value of the inductor wiring conductor and a decrease in the close contact force between the inductor wiring conductor and a member forming a base of the inductor wiring conductor.

(7) In addition, the present disclosure provides a method of manufacturing a coil component in which it is not necessary to apply a wet etching step for removing an unnecessary portion of a seed layer.

(8) A coil component according to one aspect of the present disclosure includes a main body made of a magnetic material, a linear inductor wiring conductor arranged in the main body, an electrically insulating pedestal having a top surface extending along the inductor wiring conductor in the main body and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface, and a conductive seed layer provided over an entire region of at least a region sandwiched between the top surface of the pedestal and the inductor wiring conductor.

(9) In addition, in the above-described coil component, when a width dimension in a width direction of a surface of the inductor wiring conductor in contact with the seed layer is defined as a first width dimension and a width dimension in the width direction of the seed layer is defined as a second width dimension, the second width dimension is larger than the first width dimension.

(10) A method of manufacturing a coil component according to another aspect of the present disclosure includes preparing a support substrate having a first main surface and a second main surface opposed to each other, and providing an electrically insulating pedestal on the first main surface of the support substrate, with the pedestal having a top surface extending along a linear inductor wiring conductor to be formed and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface. The method of manufacturing a coil component also includes forming a conductive seed layer so as to cover the pedestal and cover the first main surface of the support substrate exposed from the pedestal, providing a first resist on the seed layer, with the first resist having an opening that exposes the seed layer on a central portion in a width direction of the top surface of the pedestal, forming an inductor wiring conductor on the seed layer through the opening of the first resist by electrolytic plating, removing the first resist, and forming a first magnetic layer on the first main surface side of the support substrate so as to position the inductor wiring conductor inside. The method of manufacturing a coil component further includes removing the support substrate and a portion of the seed layer other than a portion

covering the pedestal from the second main surface side of the support substrate, and forming a second magnetic layer so as to be in contact with the pedestal and the first magnetic layer.
(11) According to the above-described coil component, the seed layer serving as the base of the inductor wiring conductor is provided on the pedestal, and the width dimension of the seed layer is made larger than the width dimension of the surface of the inductor wiring conductor in contact with the seed layer. Therefore, the inductor wiring conductor can be kept away from an unnecessary portion of the seed layer to be removed. Therefore, even when wet etching is applied for removing the unnecessary portion of the seed layer, for example, the inductor wiring conductor can be less likely to be affected by the wet etching. Therefore, thinning of the inductor wiring conductor results in problems such as an increase in resistance value of the inductor wiring conductor and a decrease in the close contact force between the inductor wiring conductor and a member forming a base thereof, but it is possible to make the problems less likely to occur.
(12) In addition, according to the coil component described above, since the seed layer is provided on the pedestal, it is possible to remove an unnecessary portion of the seed layer without performing a wet etching step by applying a predetermined manufacturing method.
(13) According to the method of manufacturing the coil component described above, since a step of scraping from the second main surface side of the support substrate is employed in order to remove an unnecessary portion of the seed layer, that is, a portion of the seed layer other than a portion covering the pedestal, it is not necessary to perform a wet etching step. Therefore, it is possible to avoid the problems that the inductor wiring conductor is thinned, as a result, the resistance value of the inductor wiring conductor is increased and the close contact force between the inductor wiring conductor and a member forming the base thereof is decreased.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a perspective view illustrating an appearance of a coil component;
(2) FIGS. **2**A and **2**B are an enlarged cross-sectional view illustrating a part of the coil component illustrated in FIG. **1**, FIG. **2**A illustrates a cross-section taken along a line A-A of FIG. **1**, and FIG. **2**B illustrates a cross-section taken along a line B-B of FIG. **1**;
(3) FIG. **3** is a cross-sectional view for explaining a method of manufacturing the coil component illustrated in FIG. **1**, and illustrates a part of a support substrate to be prepared;
(4) FIG. **4** is a cross-sectional view illustrating a step subsequent to the step illustrated in FIG. **3**, and illustrates a state in which a pedestal is provided on a first main surface of the support substrate in a portion corresponding to the portion illustrated in FIG. **2**A;
(5) FIG. **5** is a cross-sectional view illustrating a step subsequent to the step illustrated in FIG. **4**, and illustrates a state in which a conductive seed layer is formed so as to cover the pedestal and the first main surface of the support substrate exposed from the pedestal in a portion corresponding to the portion illustrated in FIG. **2**A;
(6) FIG. **6** is a cross-sectional view illustrating a step subsequent to the step illustrated in FIG. **5**, and illustrates a state in which a first resist having an opening for exposing the seed layer on the central portion in a width direction of a top surface of the pedestal is provided on the seed layer in a portion corresponding to the portion illustrated in FIG. **2**A;
(7) FIG. **7** is a cross-sectional view illustrating a step subsequent to the step illustrated in FIG. **6**, and illustrates a state in which an inductor wiring conductor is formed on the seed layer through the opening of the first resist by electrolytic plating in a portion corresponding to the portion illustrated in FIG. **2**A;
(8) FIG. **8** is a cross-sectional view illustrating a step subsequent to the step illustrated in FIG. **7**, and illustrates a state in which the first resist is removed in a portion corresponding to the portion

illustrated in FIG. **2**A;

(9) FIGS. **9**A and **9**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIG. **8**, FIG. **9**A illustrates a state in which a second resist is provided on the seed layer in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **9**B illustrates a state in which the second resist having an opening of a pattern corresponding to a pattern of an extended conductor electrically connected to an end portion of the inductor wiring conductor is provided on the seed layer in a portion corresponding to the portion illustrated in FIG. **2**B;

(10) FIGS. **10**A and **10**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **9**A and **9**B, FIG. **10**A illustrates a state in which the state illustrated in FIG. **9**A is maintained in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **10**B illustrates a state in which the extended conductor is formed on the end portion of the inductor wiring conductor through the opening of the second resist by electrolytic plating in a portion corresponding to the portion illustrated in FIG. **2**B;

(11) FIGS. **11**A and **11**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **10**A and **10**B, FIG. **11**A illustrates a state in which the second resist is removed in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **11**B illustrates a state in which the second resist is removed in a portion corresponding to the portion illustrated in FIG. **2**B;

(12) FIGS. **12**A and **12**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **11**A and **11**B, FIG. **12**A illustrates a state in which a first magnetic layer is provided on the first main surface side of the support substrate so as to position the inductor wiring conductor inside in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **12**B illustrates a state in which the first magnetic layer is provided so as to incorporate not only the inductor wiring conductor but also the extended conductor in a portion corresponding to the portion illustrated in FIG. **2**B;

(13) FIGS. **13**A and **13**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **12**A and **12**B, FIG. **13**A illustrates a state in which the first magnetic layer is scraped in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **13**B illustrates a state in which the first magnetic layer is scraped to expose an end surface of the extended conductor in a portion corresponding to the portion illustrated in FIG. **2**B;

(14) FIGS. **14**A and **14**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **13**A and **13**B, FIG. **14**A illustrates a state in which a solder resist is provided on the first magnetic layer in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **14**B illustrates a state in which the solder resist is provided on the first magnetic layer in a portion corresponding to the portion illustrated in FIG. **2**B;

(15) FIGS. **15**A and **15**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **14**A and **14**B, FIG. **15**A illustrates a state in which the support substrate is removed in a portion corresponding to the portion illustrated in FIG. **2**A and further, a portion of the seed layer other than a portion covering the pedestal is removed from the second main surface side of the support substrate, and FIG. **15**B illustrates a state in which the support substrate is removed in a portion corresponding to the portion illustrated in FIG. **2**B and further, a portion of the seed layer other than a portion covering the pedestal is removed from the second main surface side of the support substrate;

(16) FIGS. **16**A and **16**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **15**A and **15**B, FIG. **16**A illustrates a state in which a second magnetic layer is provided in contact with the pedestal and the first magnetic layer in a portion corresponding to the portion illustrated in FIG. **2**A, and FIG. **16**B illustrates a state in which the second magnetic layer is provided in contact with the pedestal and the first magnetic layer in a portion corresponding to the portion illustrated in FIG. **2**B;

(17) FIG. **17** is a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **15**A and **15**B, and illustrates a state in which a base layer of an external terminal electrode

electrically connected to the extended conductor is formed in a portion corresponding to the portion illustrated in FIG. **2**B;

(18) FIGS. **18**A and **18**B are an enlarged cross-sectional view illustrating a part of the coil component, FIG. **18**A illustrates a cross-section corresponding to a cross-section taken along a line A-A of FIG. **1**, and FIG. **18**B illustrates a cross-section corresponding to a cross-section taken along a line B-B of FIG. **1**;

(19) FIGS. **19**A and **19**B are a cross-sectional view for explaining a method of manufacturing a coil component **1***a* illustrated in FIGS. **18**A and **18**B, FIG. **19**A illustrates a state in which a resist is provided serving as a preparation stage of a step of removing an unnecessary portion of the seed layer in a portion corresponding to the portion illustrated in FIG. **18**A, and FIG. **19**B illustrates a state in which a resist is provided serving as a preparation stage of a step of removing an unnecessary portion of the seed layer in a portion corresponding to the portion illustrated in FIG. **18**B;

(20) FIGS. **20**A and **20**B are a cross-sectional view illustrating a step subsequent to the step illustrated in FIGS. **19**A and **19**B, FIG. **20**A illustrates a state in which an unnecessary portion of the seed layer is removed and then a resist is removed in a portion corresponding to the portion illustrated in FIG. **18**A, and FIG. **20**B illustrates a state in which an unnecessary portion of the seed layer is removed and then a resist is removed in a portion corresponding to the portion illustrated in FIG. **18**B;

(21) FIG. **21** is an enlarged cross-sectional view illustrating a formation state of the seed layer included in the coil component;

(22) FIG. **22** is an enlarged cross-sectional view illustrating a formation state of the seed layer included in the coil component;

(23) FIG. **23** is an enlarged cross-sectional view illustrating a formation state of the seed layer included in the coil component; and

(24) FIG. **24** is an enlarged cross-sectional view illustrating a part of a close contact layer formed between the pedestal and the seed layer in the coil component.

DETAILED DESCRIPTION

First Embodiment

(25) A structure of a coil component **1** according to a first embodiment of the present disclosure will be described with reference to FIG. **1** and FIGS. **2**A and **2**B.

(26) The coil component **1** includes a main body **2** made of a magnetic material. The magnetic material forming the main body **2** is made of, for example, an organic material containing a metal magnetic powder. The metal magnetic powder has, for example, an average particle diameter of equal to or less than 5 μm, and is made of an alloy containing Fe such as an Fe—Si based alloy. Note that the metal magnetic powder may be crystalline or amorphous. Note that an oxide magnetic powder such as ferrite may be used instead of the metal magnetic powder. As the organic material, for example, an epoxy resin, a mixture of an epoxy resin and an acrylic resin, or a mixture of an epoxy resin, an acrylic resin, and another resin is used.

(27) The main body **2** has a plate shape or a rectangular parallelepiped shape, and has an upper surface **3**, a lower surface **4**, and four end surfaces **5**, **6**, **7**, and **8** connecting the upper surface **3** and the lower surface **4**. The “upper surface” and the “lower surface” are based on the upper and lower sides in FIG. **1**, and do not imply the upper and lower sides of the coil component **1** in an actual use state, but may be the main surface (the widest surface) of the main body **2**. Note that a solder resist **43** described later is provided on the upper surface **3** of the main body **2**. Three linear inductor wiring conductors **9**, **10**, and **11** are arranged in the main body **2**. The inductor wiring conductors **9**, **10**, and **11** extend in a direction connecting the opposing end surfaces **5** and **6**. The inductor wiring conductors **9** and **10** have a straight shape, and the inductor wiring conductor **11** has a meander shape. In addition, the inductor wiring conductor **9** is thicker than the inductor wiring conductors **10** and **11**.

(28) Extended conductors **13** and **14** are provided at one end portion and the other end portion of the inductor wiring conductor **9**, respectively. Extended conductors **15** and **16** are provided at one end portion and the other end portion of the inductor wiring conductor **10**, respectively. Extended conductors **17** and **18** are provided at one end portion and the other end portion of the inductor wiring conductor **11**, respectively. As can be seen from the state of the extended conductor **14** illustrated in FIG. **2**B, each of the extended conductors **13** to **18** is positioned so as to overlap a corresponding end portion of each of the inductor wiring conductors **9** to **11**. In addition, each of the inductor wiring conductors **9** to **11** is wider than the other portion at each end portion connected to each of the extended conductors **13** to **18**.
(29) The inductor wiring conductors **9** to **11** and the extended conductors **13** to **18** are made of, for example, Au, Pt, Pd, Ag, Cu, Al, Co, Cr, Zn, Ni, Ti, W, Fe, Sn, or In, or a compound containing these.
(30) Six external terminal electrodes **19** to **24** are provided so as to be exposed on the outer surface of the main body **2**, more specifically, the upper surface **3**. One end portion of the inductor wiring conductor **9** is electrically connected to the external terminal electrode **19** via the extended conductor **13**, and the other end portion is electrically connected to the external terminal electrode **20** via the extended conductor **14**. One end portion of the inductor wiring conductor **10** is electrically connected to the external terminal electrode **21** via the extended conductor **15**, and the other end portion is electrically connected to the external terminal electrode **22** via the extended conductor **16**. One end portion of the inductor wiring conductor **11** is electrically connected to the external terminal electrode **23** via the extended conductor **17**, and the other end portion is electrically connected to the external terminal electrode **24** via the extended conductor **18**.
(31) Electrically insulating pedestals **25**, **26** and **27** are also provided in the main body **2**. The pedestals **25** to **27** are made of, for example, epoxy resin, acrylic resin, phenol resin, polyimide, or a mixture thereof.
(32) The pedestal **25** is best illustrated in FIGS. **2**A and **2**B. The pedestal **25** has a top surface **28** extending along the inductor wiring conductor **9** and a pair of side surfaces **29** and **30** each extending from both outer edges of the top surface **28** in a direction intersecting the top surface **28**. Although detailed illustration is omitted, the pedestal **26** has a top surface extending along the inductor wiring conductor **10** and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface, and the pedestal **27** has a top surface extending along the inductor wiring conductor **11** and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface. Note that as illustrated in FIGS. **2**A and **2**B, the side surfaces **29** and **30** of the pedestal **25** may be inclined.
(33) Note that when a gradient is expressed by an interior angle between the top surface **28** and the side surface **29** or an interior angle between the top surface **28** and the side surface **30**, the gradient is preferably equal to or more than 120° and equal to or less than 160° (i.e., from 120° to 160°). Due to the gradient being equal to or more than 120°, the seed layer **31** can be more reliably made wider than the inductor wiring conductor **9**. In addition, due to the gradient being equal to or less than 160°, the pedestal **25** does not expand excessively, the volume of the main body **2** that is a magnetic material can be ensured, and a decrease in the efficiency of obtaining an inductance value can be suppressed.
(34) A conductive seed layer **31** is provided over the entire region of at least a region sandwiched between the top surface **28** of the pedestal **25** and the inductor wiring conductor **9**. In this embodiment, the seed layer **31** is provided over the entire region of each of the top surface **28** and the side surfaces **29** and **30** of the pedestal **25**. The seed layer **31** is preferably made of a material having the same main component as the inductor wiring conductors **9** to **11**, and is made of, for example, Au, Pt, Pd, Ag, Cu, Al, Co, Cr, Zn, Ni, Ti, W, Fe, Sn, or In, or a compound thereof. Note that the seed layer **31** may have a component configuration different from that of the inductor wiring conductors **9** to **11** except for the main component depending on the difference in the

formation method. In addition, the thickness of the seed layer **31** is not particularly limited as long as electric charge can be supplied and the seed layer **31** sufficiently functions in electrolytic plating, but is desirably equal to or less than 2 μm, for example.
(35) In this embodiment, a width dimension W**21** of the seed layer **31** is larger than a width dimension W**11** of the surface of the inductor wiring conductor **9** in contact with the seed layer **31** illustrated in FIG. **2**A. Similarly, a width dimension W**22** of the seed layer **31** is larger than a width dimension W**12** of the surface of the end portion of the inductor wiring conductor **9** in contact with the seed layer **31** illustrated in FIG. **2**B. That is, the seed layer **31** is provided to extend to the outside of the inductor wiring conductor **9**.
(36) Note that the width dimensions W**11** and W**12** are defined as a "width dimension of the surface of the inductor wiring conductor **9** in contact with the seed layer **31**" because width dimensions of the inductor wiring conductor **9** other than the surface in contact with the seed layer **31** are not particularly limited. For example, as in the case where the cross-sectional shape of the inductor wiring conductor **9** illustrated in FIGS. **2**A and **2**B is an inverted trapezoid, the width dimension of the inductor wiring conductor **9** other than the surface in contact with the seed layer **31** may be the same as or wider than the width dimension W**21** or W**22** of the seed layer **31**. In addition, the width direction of the inductor wiring conductor **9** and the seed layer **31** refers to a direction parallel to the top surface **28** of the pedestal **25** in a cross section (transverse cross section) orthogonal to the direction in which the inductor wiring conductor **9** and the seed layer **31** extend.
(37) The seed layer **31** is for supplying electric charge when the inductor wiring conductor **9** is formed by electrolytic plating, and is not required after the inductor wiring conductor **9** is formed. In addition, since the seed layer **31** is made of a conductive material, this may cause an undesirable electrical short circuit. Therefore, after the inductor wiring conductor **9** is formed, an unnecessary portion of the seed layer **31** is removed. Wet etching is typically applied to remove the unnecessary portion of the seed layer **31**.
(38) It should be understood that FIGS. **2**A and **2**B illustrate a state after the unnecessary portion of the seed layer **31** is removed. Therefore, before the unnecessary portion is removed, the seed layer **31** extends widely to the side of the inductor wiring conductor **9**, for example, as illustrated in FIG. **5** to FIGS. **14**A and **14**B described later. As described above, when the width dimensions W**21** and W**22** are made wider than the width dimensions W**11** and W**12**, respectively, the inductor wiring conductor **9** can be kept away from an unnecessary portion of the seed layer **31** to be removed. Therefore, even when the wet etching is applied to the removal of the unnecessary portion of the seed layer **31**, for example, the inductor wiring conductor **9** can be less likely to be affected by the wet etching.
(39) Although description has been given about the inductor wiring conductor **9**, the pedestal **25**, and the seed layer **31** illustrated in FIGS. **2**A and **2**B, the other inductor wiring conductors **10** and **11**, the other pedestals **26** and **27**, and seed layers provided thereon have substantially the same configuration.
(40) Next, a preferred method of manufacturing the coil component **1** will be described with reference to FIG. **3** to FIG. **17**. FIG. **3** to FIG. **17** illustrate a manufacturing method relating to a portion where the inductor wiring conductor **9** is provided. For also the portions where the other inductor wiring conductors **10** and **11** are provided, the same steps as those illustrated in FIG. **3** to FIG. **17** for the portion where the inductor wiring conductor **9** is provided are performed simultaneously.
(41) First, as illustrated in FIG. **3**, a support substrate **33** is prepared. The support substrate **33** has a first main surface **34** and a second main surface **35** opposed to each other. The support substrate **33** includes a base portion **36** positioned on the second main surface **35** side and made of a material having relatively high flexural strength such as ferrite, and a coating portion **37** positioned on the first main surface **34** side and made of resin covering one main surface of the base portion **36**, such

as polyimide. The coating portion **37** is formed by, for example, applying resin onto the base portion **36** by spin coating and then curing the resin. Although not illustrated, an alignment mark is formed on the first main surface **34** provided by the coating portion **37** as necessary.

(42) Next, as illustrated in FIG. **4**, the pedestal **25** is formed on the first main surface **34** provided by the coating portion **37** of the support substrate **33**. In order to form the pedestal **25**, desired resin is spin-coated on the first main surface **34** of the support substrate **33**, and patterned through respective steps of exposure, development, and curing. Although FIG. **4** illustrates a portion corresponding to the portion illustrated in FIG. **2**A, the pedestal **25** extends to a portion corresponding to the portion illustrated in FIG. **2**B. As described above, the pedestal **25** has the top surface **28** extending along the linear inductor wiring conductor **9** to be formed, and the pair of side surfaces **29** and **30** each extending from both outer edges of the top surface **28** in a direction intersecting the top surface **28**.

(43) Next, as illustrated in FIG. **5**, the conductive seed layer **31** is formed. The seed layer **31** is formed so as to cover the pedestal **25** and the first main surface **34** of the support substrate **33** exposed from the pedestal **25** by applying Cu electroless plating, sputtering, or the like, for example.

(44) Next, as illustrated in FIG. **6**, a first resist **38** is provided on the seed layer **31**. The first resist **38** has an opening **39** that exposes the seed layer **31** on the central portion in the width direction of the top surface **28** of the pedestal **25**. The first resist **38** is formed of, for example, a dry film resist. More specifically, a dry film resist is laminated on the seed layer **31** while peeling off a protective film, and is patterned through the respective steps of exposure, development, and curing to form the first resist **38** having the opening **39**.

(45) Next, as illustrated in FIG. **7**, the inductor wiring conductor **9** is formed by electrolytic plating of a conductive metal such as Cu. The conductive metal to be the inductor wiring conductor **9** is plated and grown on the seed layer **31** to which the electric charge is supplied through the opening **39** of the first resist **38**, and becomes the inductor wiring conductor **9**.

(46) Next, as illustrated in FIG. **8**, the first resist **38** is peeled and removed.

(47) Next, as illustrated in FIGS. **9**A and **9**B, a second resist **40** is provided on the seed layer **31**. The second resist **40** has an opening **41** of a pattern corresponding to the pattern of the extended conductor **14** electrically connected to the end portion of the inductor wiring conductor **9** in a portion corresponding to the portion illustrated in FIG. **2**B illustrated in FIG. **9**B. The second resist **40** is formed of, for example, a dry film resist. More specifically, as in the case of the first resist **38**, a dry film resist is laminated on the seed layer **31** while the protective film is peeled off, and is patterned through the respective steps of exposure, development, and curing to form the second resist **40** having the opening **41**. In a portion corresponding to the portion illustrated in FIG. **2**A illustrated in FIG. **9**A, the extended conductor **14** is not formed, and thus the opening **41** is not formed.

(48) Next, as illustrated in FIGS. **10**A and **10**B, electrolytic plating of a conductive metal such as Cu is performed. At this time, in a portion corresponding to the portion illustrated in FIG. **2**B illustrated in FIG. **10**B, the extended conductor **14** is formed on the end portion of the inductor wiring conductor **9** through the opening **41** of the second resist **40** by electrolytic plating. The extended conductor **14** is preferably made of the same material as that of the inductor wiring conductor **9**. In a portion corresponding to the portion illustrated in FIG. **2**A illustrated in FIG. **10**A, the state illustrated in FIG. **9**A is maintained.

(49) Next, as illustrated in FIGS. **11**A and **11**B, the second resist **40** is peeled and removed.

(50) Next, as illustrated in FIGS. **12**A and **12**B, a first magnetic layer **42** is provided on the first main surface **34** side of the support substrate **33** so as to position the inductor wiring conductor **9** inside. At this time, in a portion corresponding to the portion illustrated in FIG. **2**B illustrated in FIG. **12**B, the first magnetic layer **42** incorporates not only the inductor wiring conductor **9** but also the extended conductor **14**. In a portion corresponding to the portion illustrated in FIG. **2**A

illustrated in FIG. **12**A, the first magnetic layer **42** incorporates only the inductor wiring conductor **9**. The first magnetic layer **42** serves as a part of the main body **2** and is formed, for example, by pressing a sheet made of an organic material containing metal magnetic powder to obtain the state illustrated in FIGS. **12**A and **12**B and then performing curing.

(51) Next, as illustrated in FIGS. **13**A and **13**B, a step of scraping the first magnetic layer **42** from the surface facing outward is performed. This step is performed until at least the end surface of the extended conductor **14** is exposed in a portion corresponding to the portion illustrated in FIG. **2**B illustrated in FIG. **13**B, and preferably until the end surface of the extended conductor **14** is ground to be smooth. In a portion corresponding to the portion illustrated in FIG. **2**A illustrated in FIG. **13**A, the thickness of the first magnetic layer **42** is reduced while maintaining the state in which the inductor wiring conductor **9** is incorporated.

(52) Next, as illustrated in FIGS. **14**A and **14**B, the solder resist **43** is provided on the surface of the first magnetic layer **42** through respective steps of printing, exposure, development, and curing. In a portion corresponding to the portion illustrated in FIG. **2**B illustrated in FIG. **14**B, an opening **44** for exposing the end surface of the extended conductor **14** is provided in the solder resist **43**. In a portion corresponding to the portion illustrated in FIG. **2**A illustrated in FIG. **14**A, no opening is provided in the solder resist **43**.

(53) Next, as illustrated in FIGS. **15**A and **15**B, in order to expose the pedestal **25** on the second main surface **35** side of the support substrate **33**, the support substrate **33** and portions of the seed layer **31** other than the portion covering the pedestal **25** are removed from the second main surface **35** side of the support substrate **33** (see FIGS. **14**A and **14**B). In this way, unnecessary portions of the seed layer **31** can be removed without performing a wet etching step.

(54) Next, as illustrated in FIGS. **16**A and **16**B, a second magnetic layer **45** is provided so as to be in contact with the pedestal **25** and the first magnetic layer **42**. The second magnetic layer **45** is formed, for example, by pressing a sheet made of an organic material containing metal magnetic powder to obtain the state illustrated in FIGS. **16**A and **16**B and then performing curing. The second magnetic layer **45** and the above-described first magnetic layer **42** configure the main body **2**.

(55) Note that the step of providing the solder resist **43** on the surface of the first magnetic layer **42** illustrated in FIGS. **14**A and **14**B may be performed after the step of removing the support substrate **33** illustrated in FIGS. **15**A and **15**B or after the step of providing the second magnetic layer **45** illustrated in FIGS. **16**A and **16**B.

(56) Next, as illustrated in FIG. **17**, a base layer **46** of the external terminal electrode **20** electrically connected to the extended conductor **14** is formed in the opening **44** of the solder resist **43** in a portion corresponding to the portion illustrated in FIG. **2**B. The base layer **46** is provided by, for example, a Cu electroless plating layer, and further, as illustrated in FIG. **2**B, a surface layer **47** composed of, for example, an Ni plating layer and an Au plating layer by electrolytic plating is formed on the base layer **46**.

(57) The coil component **1** is manufactured in this manner, however, in a case where a plurality of the coil components **1** is simultaneously manufactured by the above-described steps, that is, being manufactured in a mother state, a step of cutting an assembly of the coil components **1** in the mother state by, for example, a dicer is performed thereafter.

Second Embodiment

(58) A second embodiment of the present disclosure will be described with reference to FIGS. **18**A and **18**B to FIGS. **20**A and **20**B. In FIGS. **18**A and **18**B to FIGS. **20**A and **20**B, elements corresponding to those illustrated in FIGS. **2**A and **2**B to FIG. **17** are denoted by the same reference numerals, and redundant description will be omitted.

(59) FIGS. **18**A and **18**B are diagrams corresponding to FIGS. **2**A and **2**B. In the coil component **1** according to the first embodiment described above, the seed layer **31** is provided on the entire region of each of the top surface **28** and the side surfaces **29** and **30** of the pedestal **25**, however, in

a coil component **1***a* according to the second embodiment, the seed layer **31** is provided only on the top surface **28** of the pedestal **25**.
(60) In order to manufacture the coil component **1***a* according to the second embodiment, first, the steps up to the step illustrated in FIGS. **11**A and **11**B in the manufacturing method according to the first embodiment are performed in the same manner.
(61) Following the step illustrated in FIGS. **11**A and **11**B, a resist **51** is provided on the seed layer **31**, as illustrated in FIGS. **19**A and **19**B. The resist **51** is formed of, for example, a dry film resist. More specifically, a dry film resist is laminated on the seed layer **31** while the protective film is peeled off, and is patterned through the respective steps of exposure, development, and curing. As such, the resist **51** is formed in a manner so as to cover the inductor wiring conductor **9** and a portion of the seed layer **31** positioned on the top surface **28** of the pedestal **25** in a portion corresponding to the portion illustrated in FIG. **2**A illustrated in FIG. **19**A, and cover the inductor wiring conductor **9** and the extended conductor **14** and cover a portion of the seed layer **31** positioned on the top surface **28** of the pedestal **25** in a portion corresponding to the portion illustrated in FIG. **2**B illustrated in FIG. **19**B.
(62) Next, in the state illustrated in FIGS. **19**A and **19**B, a wet etching step is performed on the seed layer **31**. As a result, the seed layer **31** is removed in the portion exposed from the resist **51**. In this way, FIGS. **20**A and **20**B illustrates a state in which the resist **51** has been removed after the unnecessary portion of the seed layer **31** has been removed.
(63) Thereafter, substantially the same steps as the steps of providing the first magnetic layer **42** illustrated in FIGS. **12**A and **12**B described above, scraping the first magnetic layer **42** to expose the end surface of the extended conductor **14** illustrated in FIGS. **13**A and **13**B, providing the solder resist **43** on the first magnetic layer **42** illustrated in FIGS. **14**A and **14**B, removing the support substrate **33** illustrated in FIGS. **15**A and **15**B, providing the second magnetic layer **45** so as to be in contact with the pedestal **25** and the first magnetic layer **42** illustrated in FIGS. **16**A and **16**B, and forming the base layer **46** of the external terminal electrode **20** illustrated in FIG. **17** are performed, and further, the surface layer **47** of the external terminal electrode **20** is formed, thereby obtaining the coil component **1***a* illustrated in FIGS. **18**A and **18**B.
(64) According to the second embodiment, when the unnecessary portion of the seed layer **31** is removed, the inductor wiring conductor **9** is protected during wet etching so that the inductor wiring conductor **9** is not thinned, as compared with the case where wet etching is applied while the state illustrated in FIGS. **11**A and **11**B remains without taking any measures, for example. In addition, as compared with the case where the wet etching is applied in the state illustrated in FIGS. **11**A and **11**B to remove an unnecessary portion of the seed layer **31**, an area where the seed layer **31** is in contact with the pedestal **25** is increased, and a close contact force of the seed layer **31** to the pedestal **25** can be improved.
Third to Fifth Embodiments
(65) Third to fifth embodiments will be described with reference to the pedestal **25** illustrated in FIG. **21** to FIG. **23**. Although the description is omitted, the same applies to the other pedestals **26** and **27**.
(66) In the first embodiment, wet etching is not applied at all, but in the third to fifth embodiments, wet etching is performed for a short time in the state illustrated in FIGS. **11**A and **11**B. Therefore, the seed layer **31** is incompletely etched in a portion exposed from the inductor wiring conductor **9**.
(67) More specifically, in the third embodiment illustrated in FIG. **21**, the seed layer **31** is incompletely etched on a part of the top surface **28** and a part of each of the side surfaces **29** and **30** of the pedestal **25**.
(68) In the fourth embodiment illustrated in FIG. **22**, the seed layer **31** is incompletely etched on a part of the top surface **28** of the pedestal **25**.
(69) In the fifth embodiment illustrated in FIG. **23**, the seed layer **31** is incompletely etched on a part of each of the side surfaces **29** and **30** of the pedestal **25**.

(70) The incomplete etching applied in the third to fifth embodiments described above results in the formation of a discontinuous portion in the seed layer **31** on a part of at least one of the top surface **28** and the side surfaces **29** and **30** of the pedestal **25**.
(71) According to the third to fifth embodiments, as compared with the second embodiment, the contact area between the seed layer **31** and the pedestal **25** is increased, or the distribution region of the contact portion between the seed layer **31** and the pedestal **25** is widened, so that the close contact force of the seed layer **31** to the pedestal **25** can be improved. In addition, according to the third to fifth embodiments, although not illustrated in FIG. **21** to FIG. **23**, since a rough surface is formed at the boundary between the pedestal **25** and the first magnetic layer **42**, the effect of improving the close contact force between the first magnetic layer **42** and the pedestal **25** can be expected.
Sixth Embodiment
(72) Referring to FIG. **24**, a sixth embodiment will be described in relation to the pedestal **25**. Although the description is omitted, the same applies to the other pedestals **26** and **27**.
(73) The sixth embodiment is characterized in that a close contact layer **53** for improving a close contact property between the seed layer **31** and the pedestal **25** is further provided between the seed layer **31** and the pedestal **25**. As the material of the close contact layer **53**, a material suitable for the purpose of improving the close contact force can be appropriately selected as long as it does not affect the formation of the inductor wiring conductor **9**. As an example, in a case where Ti is not used as the material of the seed layer **31**, the close contact layer **53** is preferably formed by a Ti layer.
(74) The sixth embodiment can be applied in combination with any one of the first to fifth embodiments described above.
(75) Although the present disclosure has been described with reference to several embodiments illustrated in the drawings, various other modifications are possible within the scope of the present disclosure.
(76) For example, the form, number, and the like of the inductor wiring conductors in the coil component can be arbitrarily changed according to the design. The inductor wiring conductor may extend in a spiral shape, for example.
(77) In addition, regarding the structure of the coil component according to the present disclosure, a method of forming the inductor wiring conductor is not limited, and an electroless plating method, a sputtering method, a vapor deposition method, a printing method, or the like may be applied in addition to the electrolytic plating method described above.
(78) In addition, each embodiment described in this specification is an example, and it is possible to partially replace or combine configurations between different embodiments.

Claims

1. A coil component comprising: a main body including a magnetic material; a linear inductor wiring conductor arranged in the main body; an electrically insulating pedestal having a top surface extending along the inductor wiring conductor in the main body and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface, and at least one of the side surfaces is inclined with respect to the top surface; and a conductive seed layer over an entire region of at least a region sandwiched between the top surface of the pedestal and the inductor wiring conductor, wherein when a width dimension in a width direction of a surface of the inductor wiring conductor in contact with the seed layer is defined as a first width dimension and a width dimension in the width direction of the seed layer is defined as a second width dimension, the second width dimension is larger than the first width dimension.
2. The coil component according to claim 1, further comprising: an external terminal electrode exposed on an outer surface of the main body; and an extended conductor that is positioned so as to

overlap an end portion of the inductor wiring conductor and electrically connects the end portion of the inductor wiring conductor to the external terminal electrode.
3. The coil component according to claim 2, wherein the seed layer is on the top surface and the side surface of the pedestal.
4. The coil component according to claim 2, wherein the seed layer is on the top surface of the pedestal, but is absent from the side surface of the pedestal.
5. The coil component according to claim 2, further comprising: a close contact layer configured to improve a close contact property between the seed layer and the pedestal.
6. The coil component according to claim 2, wherein the inductor wiring conductor and the seed layer include materials having the same main component.
7. The coil component according to claim 2, wherein the pedestal includes resin.
8. The coil component according to claim 1, wherein the seed layer is on the top surface of the pedestal, but is absent from the side surface of the pedestal.
9. The coil component according to claim 1, wherein the inductor wiring conductor and the seed layer include materials having the same main component.
10. The coil component according to claim 1, wherein the pedestal includes resin.
11. The coil component according to claim 1, wherein the side surfaces meet the top surface at opposite edges of the top surface, and a distance between the opposite edges is greater than the first width dimension.
12. A coil component comprising: a main body including a magnetic material; a linear inductor wiring conductor arranged in the main body; an electrically insulating pedestal having a top surface extending along the inductor wiring conductor in the main body and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface; and a conductive seed layer over an entire region of at least a region sandwiched between the top surface of the pedestal and the inductor wiring conductor, wherein when a width dimension in a width direction of a surface of the inductor wiring conductor in contact with the seed layer is defined as a first width dimension and a width dimension in the width direction of the seed layer is defined as a second width dimension, the second width dimension is larger than the first width dimension, and the seed layer is on the top surface and the side surface of the pedestal.
13. The coil component according to claim 12, wherein the seed layer is over an entire region of each of the top surface and the side surface of the pedestal.
14. The coil component according to claim 13, further comprising: a close contact layer configured to improve a close contact property between the seed layer and the pedestal.
15. The coil component according to claim 12, wherein the seed layer has a discontinuous portion on a part of at least one of the top surface and the side surface of the pedestal.
16. The coil component according to claim 12, further comprising: a close contact layer configured to improve a close contact property between the seed layer and the pedestal.
17. The coil component according to claim 12, wherein the inductor wiring conductor and the seed layer include materials having the same main component.
18. The coil component according to claim 12, wherein the pedestal includes resin.
19. A coil component comprising: a main body including a magnetic material; a linear inductor wiring conductor arranged in the main body; an electrically insulating pedestal having a top surface extending along the inductor wiring conductor in the main body and a pair of side surfaces each extending from both outer edges of the top surface in a direction intersecting the top surface; a conductive seed layer over an entire region of at least a region sandwiched between the top surface of the pedestal and the inductor wiring conductor; and a close contact layer configured to improve a close contact property between the seed layer and the pedestal, wherein when a width dimension in a width direction of a surface of the inductor wiring conductor in contact with the seed layer is defined as a first width dimension and a width dimension in the width direction of the seed layer is

defined as a second width dimension, the second width dimension is larger than the first width dimension.