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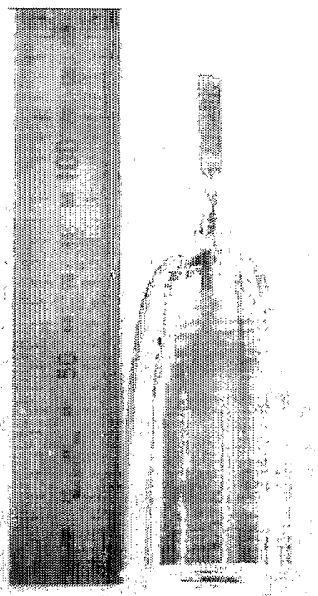
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(54) Title: SINGLE CRYSTAL WIRE AND MANUFACTURING METHOD OF THE SAME



(57) Abstract: Disclosed are a single crystal wire and a manufacturing method thereof. The method comprises the steps of: placing into a growth crucible at least one metal selected from the group consisting of gold, copper, silver, aluminum and nickel; heating and melting the metal placed in the growth crucible; growing a single crystal using the metal crystal as a seed by the Czochralski or Bridgman method; cutting the grown single crystal by electric discharge machining; and forming the cut single crystal into a wire. In the method, the grown metal single crystal is formed into a disc-shaped piece by electric discharge machining. The piece is formed into a single crystal wire by wire-cut electric discharge machining, and the single crystal wire can be used as a ring, a pendant or a wire within a high-quality cable making a connection in audio and video systems. Also, the single crystal formed into the disc-shaped piece by electric discharge machining can be used as a substrate and a target for deposition.

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Description

SINGLE CRYSTAL WIRE AND MANUFACTURING METHOD OF THE SAME

Technical Field

- [1] The present invention relates to a single-crystal wire and a manufacturing method thereof, and more particularly to a single-crystal wire manufactured by growing a single crystal through a single crystal growth method and machining the grown single crystal into a wire, as well as a manufacturing method thereof.

Background Art

- [2] The concept of high-quality cables was not generally established until the 1970s, but since the development of oxygen-free copper (hereinafter, referred to as "OFC"), the development of cables has rapidly progressed.
- [3] Particularly in the case of wire cables making connections in audio systems, etc., it is well known that the quality of cables influences the quality of sound. Thus, replacement of low-quality cables with high-quality cables can provide a great improvement in sound quality.
- [4] When such wires are applied with alternating current, an alternating magnetic field will occur, which acts as resistance to the alternating current. Particularly, the higher the frequency, the higher the resistance, and this property is called "inductance". In the case of cables, if coated wires are coiled in a circular form or formed with positive and negative terminals, the inductance will increase, resulting in a reduction in the purity of sound. However, if coated wires are formed with positive and negative terminals and then twisted like a rope, the inductance will decrease instead, resulting an increase in the purity of sound.
- [5] In general, when cables are twisted, the inductance will decrease but the capacitance will increase to make the frequency narrower and the sound muddy. Although it is a clear fact that the sound quality of audio systems differs depending on the cables used, the reason therefor has not yet been clearly established.
- [6] For example, an increase in the purity of wires leads to an increase in the purity of sound but generally results in an increase in direct current resistance, which may also reduce the cable's energy. Although the sound quality of cables is influenced by the material and physical properties of the wires themselves, it is also highly influenced by the covering material and crystalline structure of wires, the inductance, capacitance and skin effect caused by terminal processing, and the impedance between audio systems.
- [7] Namely, although the sound quality of most cables is influenced by the properties

of the wires themselves, it is also influenced by a covering material for the cables, the crystalline structure of the wires, etc.

- [8] Thus, OFC cables having a purity of 99.99% frequently have better sound quality than 6N copper wire cables having a purity of 99.9999%. Metal conductors for the wires include silver, gold, copper and aluminum, in descending order from highest electrical conductivity to lowest. Among them, copper is most frequently used as a conductor, because it is inexpensive and has good electrical conductivity and processability.
- [9] Conventional copper wires have a standard purity of 3N (99.9%), and during production, oxygen is blown to increase the workability thereof, while copper produced in an atmosphere having no oxygen is called "OFC". Other examples of copper wires include 6N (99.9999%), 7N (99.99999%), etc., according to the extent of removal of metals and sulfur, which are impurities other than oxygen. Prior methods for manufacturing copper wires will now be described.
- [10] The production of tough pitch copper (hereinafter, referred to as "TPC") is a general copper production method comprising introducing oxygen to melt copper and rapidly cooling the melted copper. This method is suitable for mass production and produces a 3N-purity copper containing sulfur and cuprous oxide and having an oxygen content of 3000-4000 ppm and a purity of 99.9%.
- [11] OFC is copper from which the development of high-purity copper started. The OFC is a 4N (99.99%) product which has an oxygen content reduced to less than 10 ppm by removing a cuprous oxide impurity, unlike the existing TPC process comprising blowing oxygen to cool the molten copper. The use of the OFC allowed muddy sound to be removed and the purity of sound to be increased, thus improving sound clarity.
- [12] Linear crystal oxygen-free copper (hereinafter, referred to as "LC-OPC") was developed based on the theory that every factor reducing the sound quality exists at boundaries between metal crystals. When copper is rapidly cooled in a melted state, it will have a fine crystal structure, in which case an increase in crystals will increasingly interfere with signal transmission. Based on this theory, in order for the OFC to have a unidirectional crystal structure, copper is slowly cooled to obtain large crystals, and the resulting copper crystal structure is then linearly stretched. However, during the process for linearly stretching the copper crystal structure, mechanical stress and heat are generated in the copper, so that the copper crystal structure is adversely affected, thus causing deterioration in sound quality.
- [13] Pure crystal ohno continuous casting (hereinafter, referred to as "PCOCC") was developed to complement the shortcoming of the LC-OPC, in which, during the process for linearly stretching the copper crystal structure, mechanical stress and heat are generated in the copper, so that the copper crystal structure is adversely affected,

thus causing deterioration in sound quality. This continuous casting is produced as a single crystal by using an additional structure for slow cooling.

[14] Typical examples of conductors having a high strength include LC-OFC and PCOCC, which have not been subjected to a thermal treatment process in order to prevent their single crystal structure from being changed. However, the copper wires, which have not been subjected to the thermal treatment process, undergo mechanical stress during their machining so that their crystal structure is influenced. To solve this shortcoming, a myu (m) conductor was developed which has been slightly thermally treated to reduce mechanical stress. In the existing technologies for developing wires, it can be seen that the structure of a single crystal acts as an important factor in manufacturing high-quality cables. However, technology for preventing the single crystal structure from being changed has not yet been developed.

[15] Meanwhile, silver (Ag) has excellent electrical properties, particularly low electrical resistance, compared to copper. Thus, in audio cables, silver is clearly advantageous compared to copper, particularly when in an oxidized state. Namely, copper is easily oxidized to form a coating film such as a semiconductor film, whereas oxidized silver has an advantage in that it is chemically stable, so that it can sufficiently function as a conductor.

[16] Like the case of copper wires, silver conductors have been continuously improved through an increase in their purity and by the use of thermal treatment. Thus, it is known that recent silver wire and silver-coated OFC wire developed for exclusive use in audio systems carry a lot of information and produce smooth sound, unlike a silver wire for use in general telecommunication.

[17] Aluminum is a conductor having highly specific properties, like silver. It is known that aluminum is slightly higher in electrical resistance than copper but also that it produces a highly specific sound in a wide sound range. Thus, an aluminum wire containing silver or aluminum produces a unique and elegant sound.

[18] Accordingly, to ensure high-quality cables, technology for manufacturing a copper, silver or aluminum wire using a high-purity single crystal urgently needs to be developed.

Disclosure of Invention

Technical Problem

[19] Therefore, the present invention has been made to solve the above-described problems occurring in the prior art, and it is an object of the present invention to provide a method for manufacturing a single crystal wire, comprising growing a metal single crystal using a seed crystal and then forming the grown metal single crystal into a disc-shaped piece which is then formed into a wire.

Technical Solution

[20] To achieve the above object, the present invention provides a method for manufacturing a single crystal wire, comprising the steps of: placing into a growth crucible at least one metal selected from the group consisting of gold, copper, silver, aluminum and nickel; heating and melting the metal placed in the growth crucible; growing a single crystal using the metal crystal as a seed by the Czochralski or Bridgman method; cutting the grown single crystal by electric discharge machining; and forming the cut single crystal into a wire.

[21] In the inventive method, the growth crucible is preferably selected from the group consisting of a graphite crucible, a boron nitride (BN) crucible, an alumina crucible, and a quartz crucible. The heating of the metal placed in the growth crucible is preferably performed using an RF induction coil or a carbon heater. Also, in the cutting step, the single crystal is preferably formed into a disc shape. After the cutting step, the cut single crystal is preferably formed into a wire by wire-cut electric discharge machining or press machining using a mold having a pattern. Also, the single crystal formed into the disc shape is preferably used as a metal single crystal substrate or a metal deposition target. Also, the wire formed by the pressing machining has a ring shape.

[22] Moreover, in the cutting step, the single crystal is preferably formed into a cylindrical shape. Also, the cylindrical shape formed in the cutting step is preferably cut into a ring shape. Also, after the cutting step, the single crystal is preferably subjected to a polishing or wet etching process.

[23] Also, the wire is preferably covered with synthetic resin on the outer surface thereof, and both ends of the wire are provided with terminals.

[24] In another aspect, the present invention provides a single crystal wire manufactured by: heating and melting at least one metal selected from the group consisting of gold, copper, silver, aluminum and nickel; growing a single crystal using the metal crystal as a seed by the Czochralski or Bridgman method; and cutting the grown single crystal.

[25] Herein, the cut single crystal is preferably formed into a ring shape or a wire shape for use as a connection cable.

[26] Also, the connection cable formed into the wire shape is preferably covered with synthetic resin on the outer surface thereof, and both ends of the connection cable are preferably provided with terminals.

Advantageous Effects

[27] According to the present invention, the metal single crystal is grown using the seed crystal and then formed into a disc-shaped piece by electrical discharge machining, and the piece is subjected to wire-cut discharge machining. Accordingly, various single-

crystal wires and wire products having a unidirectional crystal structure can be formed.

[28] Also, the single-crystal wire can be used as products, such as a ring, a pendant or a wire in a high-quality cable making a connection in audio and video systems.

[29] In addition, the single crystal formed into the disc shape can be used as a single crystal substrate for the fabrication of thin films or a target for metal deposition.

Brief Description of the Drawings

[30] FIG. 1 is a photograph showing a copper-single crystal formed according to an embodiment of the present invention.

[31] FIG. 2 is a photograph showing a wire formed according to an embodiment of the present invention.

[32] FIG. 3 is shows a disc-shaped single crystal piece and mold according to an embodiment of the present invention.

[33] FIG. 4 shows the step of machining a single crystal into a ring shape, according to an embodiment of the present invention.

[34] FIG. 5 shows XRD results for a copper single-crystal wire and a polycrystal copper wire.

[35] FIG. 6 shows GDS results for a copper single-crystal wire and a polycrystal copper wire.

[36] FIG. 7 shows surface image photographs of a copper single crystal wire (a) and a polycrystal copper wire (b).

[37] FIG. 8 shows the comparison of resistivity between a copper single crystal wire and a polycrystal copper wire.

[38] FIG. 9 shows sound cables produced by covering the outer surface of copper single crystal wires with insulation leather.

[39] FIG. 10 shows the comparison of impedance as a function of frequency between a single crystal cable and a polycrystal cable.

Best Mode for Carrying Out the Invention

[40] Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.

[41] First, a metal mass to be grown, which is at least one selected from the group consisting of gold, copper, silver, aluminum and nickel, is placed into a growth crucible (BN crucible, quartz crucible, graphite crucible, alumina crucible, etc.) in which the metal mass is then melted either by induction heating using an induction coil or by a carbon heater. The growth crucible used in the present invention is either the graphite crucible or a double crucible structure in which the outer crucible is the graphite crucible and the inner crucible is one selected from among the BN crucible, the quartz crucible and alumina crucible.

- [42] The growth of a copper or silver single crystal will now be described in detail.
- [43] Since copper and silver are not chemically bound to carbon, the graphite crucible or the double crucible structure having the graphite crucible as an outer crucible is used as the growth crucible. The reason why the growth crucible is used as a heating element is that the temperature of induction heating will be difficult to control when the amount of melted mass remaining in the crucible during the growth of a metal single crystal is reduced. Thus, it is easy in the growth of a metal single crystal to use the growth crucible as a heating element to control the temperature of the crucible itself. The growth crucible, copper and silver are induction-heated to the melting points of the metals. Since the melting points of copper and silver are 1083 °C and 962 °C, respectively, they are heated to temperatures higher than the melting points by about 30 °C so as to dissolve them completely.
- [44] A seed crystal having the desired crystal structure is prepared and grown into a single crystal by the Czochralski method. The seed crystal is prepared in the form of a rod in each of the (100), (110) and (111) directions. The growth of the copper single crystal is performed at a temperature of 1100-1000 °C, and the growth of the silver crystal is performed at a temperature of 1000-900 °C. Also, the growth of each of copper and silver is performed according to the Czochralski method, in which the temperature of a liquid phase is lowered at a rate of about 1 °C/min.
- [45] Although the method for growing the single crystal using the Czochralski has been described above, the Bridgman method may also be used for the growth of single crystals, and the use of the Bridgman method is also within the scope of the present invention.
- [46] According to the above procedure, a copper single-crystal as shown in FIG. 1 is formed.
- [47] Then, the formed single crystal is used to produce a wire. For this purpose, the grown high-purity single crystal is cut into a disc-shaped piece having the desired thickness by electric discharge machining. In this regard, the electric discharge machining is adopted in order to minimize deformation caused by stress generated in machining copper and silver into the disc-shaped piece.
- [48] The thickness of the disc-shaped piece is determined depending on the diameter of a wire to be produced, and in the present invention, the disc-shaped disc has a small thickness of about 1 mm.
- [49] Since the produced disc-shaped piece should be formed into a 1-mm-diameter wire by wire-cut electric discharge machining, it is polished with alumina powder having a particle size of 0.3 μ in order to completely remove stress remaining on the surface of the disc-shaped piece.
- [50] To obtain the desired wire from the disc-shaped piece subjected to the polishing

step, the disc-shaped disc is fixed using an outer mold and then formed into a wire by wire-cut electric discharge machining. To form the wire from the disc-shaped piece, the disc-shaped piece is cut from the outside to the inside of a cross-section thereof so as to form a wire having the desired thickness, and a separate winding process is performed to prevent twisting of the wire during the electric discharge machining.

[51] Alternatively, the wire may also be formed by forming a small hole in the central portion of the disc using a wire drill and then cutting the disc from the inside to the outside of a cross section thereof so as to form a wire having the desired diameter.

[52] Since the wire obtained according to the above process has the effect of stress due to the machining step, optical polishing of the wire is required. This optical polishing is performed using alumina powder in the same manner as in the polishing of the disc-shaped piece so as to remove the effect of stress remaining on the surface of the wire.

[53] Alternatively, the effect of stress formed on the surface of the wire may also be removed using a hydrofluoric acid dilution. The effects of stress on the metal surface during the electric discharge machining mostly consist of oxide films. Such oxide films can be removed through a wet etching process using a solution of $H_2O:HF=5:1$, in which the wet etching is performed for about 3 minutes.

[54] The wire produced through this process is shown in FIG. 2.

[55] The surface-polished or wet-etched wire can be used as a connection cable making connections in audio systems, etc. For use as the cable, the wire is covered with any material on the outer surface thereof.

[56] The process for covering the wire is performed by a known method or a manual process to make a cable. Thus, the single crystal wire product required for the transmission of commercial sounds and image data is produced.

[57] Generally, the wire is covered with, for example, an insulating shrinkable tube having a diameter larger than that of the wire. Namely, for use as a sound cable, the wire is covered with a polyurethane or insulating shrinkable tube to the required diameter so as to produce a single crystal wire product in which the wire is protected from oxidation or external stress.

[58] Also, for use as a coaxial cable, the wire is covered sequentially with a synthetic resin coating and a natural leather coating so as to produce a single-crystal product which is protected from the noise of external current. Also, both ends of the cable are terminated with RCA terminals or terminals made of metal single crystals so that the cable is protected from noise during use as a connection in audio and video systems, thus increasing the quality of sound.

[59] Although the method for forming the wire using the disc-shaped piece has been described herein, the disc-shaped piece may also be used as a unidirectional substrate or target for deposition, in which case it can be used a target having a size of 2, 3 or 4

inches. In order for the disc-shaped piece to have a precise outer diameter, the disc-shaped piece formed by electric discharge machining is re-machined to the desired diameter, or the copper single crystal is subjected to electric discharge machining to have the desired outer diameter, so that it can be used as a target or substrate for deposition. This process is also within the scope of the present invention.

[60] Although the method for forming the wire by electric discharge machining has been described above, the wire may also be formed using a mold as shown in FIG. 3.

[61] As shown in FIG. 3, a disc-shaped piece 100 formed by electric discharge machining is placed on a mold 110 having the desired pattern 111 formed thereon and then subjected to press machining, so as to form a wire having the same shape as the pattern 111 of the mold 110. Namely, when the mold 110 having the pattern 111 as shown in FIG. 3 is used, a ring-shaped wire will be obtained, and when a mold having patterns continuously connected with each other is used, a continuous wire will be obtained.

[62] In this regard, the ring-shaped wire can be used as a ring or pendant, and the continuous wire is subjected to post-machining, such as optical polishing, in the same manner as when forming the wire by milling operations, including electric discharge machining, so as to produce a single-crystal cable. Alternatively, the continuous wire is subjected to wet etching to remove an oxide film from the surface thereof so as to produce a single-crystal cable.

[63] Although the continuous single crystal wire cable has been described above, the single crystal grown according to the Czochralski or Bridgman method as described above can be used to produce a highly pure ring. For this purpose, the upper surface of the single crystal grown as shown in FIG. 1 is cut with a wire-cut electric discharge machine. Then, as shown in FIG. 4, the resulting crystal is cut into a column shape using a wire electric discharge drill having a diameter of less than 0.5 mm and a wire-cut electric discharge machine. Then, the column-shaped material is subjected to electric discharge machining to form a cylindrical body 120, which is then cut in the horizontal direction to produce a highly pure ring. The machining of the metal using the electric discharge machine is performed using known technology. However, to prevent the oxidation of the product and to give high-added value to the product by fine machining, it is also possible to use spearhead machines, such as non-electric discharge machines.

[64] The ring products manufactured according to the above method may be used as an aid for promoting human health. In the ring containing metal atoms arranged in one direction, a change in the magnetic field induced by an electric current in the ring or an eddy current induced by this change in the magnetic field will be increased compared to that in a general metal ring. Namely, in the ring having metal atoms arranged in one

direction, factors interfering with electric current will be reduced owing to its structural stability so that the amount of electric current induced in the ring will be larger than that in a general metal ring. Thus, the amount of eddy current produced in the single crystal ring will stimulate the blood flow of the human body to make it smooth, and when biomagnetic changes caused by this change in the blood flow are accumulated over time, the change of the blood flow becomes active compared to that in a general person. The fact that smooth and active blood flow is favorable to the health of the human body is well supported by modern medical science.

- [65] In order to examine whether the high-purity single crystal wire prepared by the above method overcomes the problems of the existing crystal structure, the single crystal wire produced using the copper-single crystal, and a polycrystal copper wire cured in a molten state, were analyzed using XRD. The analysis results are shown in FIG. 5.
- [66] As can be seen in FIG. 5, the single-crystal wire produced by the above method had a unidirectional crystal structure similar to that of the seed crystal.
- [67] Also, to examine the contents of impurities required for use as a commercial wire, the polycrystal copper and the single crystal were analyzed by glow discharge spectroscopy, and the results are shown in FIG. 6.
- [68] As can be seen in FIG. 6, the produced single crystal had a purity of 5N, indicating that it can be used as a wire.
- [69] The surface of the produced single-crystal wire and the surface of a polycrystal copper wire were etched and the results are shown in FIG. 7.
- [70] As can be seen in FIG. 7, in the polycrystal wire, an etching pattern showing the crystal direction was not formed, but in the single-crystal wire, a square etched pattern showing the (100) direction was formed.
- [71] The above results suggest that the produced single crystal wire is a single crystal, which is highly pure and has a unidirectional crystal structure.
- [72] This single crystal wire was measured for resistivity with a change in temperature, and the results are shown in FIG. 8.
- [73] The resistivity of the polycrystal copper wire is known to be $1.7 \times 10^{-6} \Omega\text{cm}$ for highly pure copper. As can be seen in FIG. 8, however, the resistivity of the single crystal wire prepared according to the invention was $1.2 \times 10^{-7} \Omega\text{cm}$ and was much lower with a decrease in temperature than that of the polycrystal copper wire.
- [74] As shown in FIG. 9, the single crystal wire was finally covered with natural leather on the outer surface thereof. As a result, the inventive cable was markedly superior in sound signal transmission to the existing polycrystal product. This is demonstrated from results shown in FIG. 10.
- [75] As can be seen in FIG. 10, in the single crystal wire, the inventive single crystal

cable was completely protected from external sound and magnetic waves owing to the characteristics of the natural leather. Thus, the impedance as a function of frequency was constantly lower over the entire frequency region than that of the existing polycrystal cable.

Industrial Applicability

[76] The single crystal wire manufactured by the present invention and the manufacturing method thereof is applicable in various fields. Particularly, the present invention can be applicable for commercial image and sound cables, precious metal rings and various medical accessories, and thus, is an excellent technology from an industrial point of view.

[77]

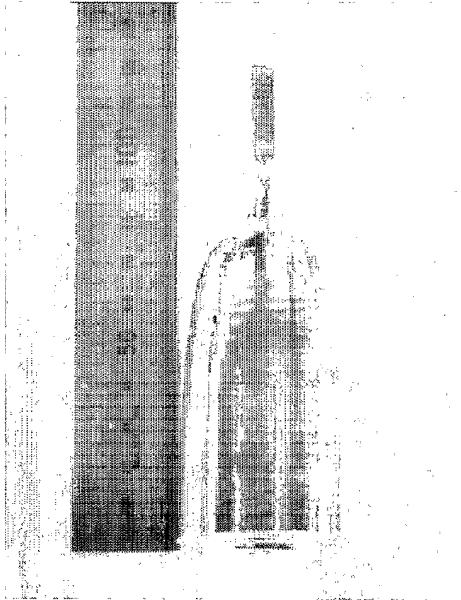
Claims

- [1] A method for manufacturing a single crystal wire, comprising the steps of:
placing into a growth crucible at least one metal selected from the group consisting of gold, copper, silver, aluminum and nickel;
heating and melting the metal placed in the growth crucible;
growing a single crystal using the metal crystal as a seed by the Czochralski or Bridgman method; cutting the grown single crystal by electric discharge machining; and forming the cut single crystal into a wire.
- [2] The method of Claim 1, wherein the growth crucible is one selected from the group consisting of a graphite crucible, a boron nitride (BN) crucible, an alumina crucible, and a quartz crucible.
- [3] The method of Claim 1 or 2, wherein the heating of the metal placed in the growth crucible is performed using an RF induction coil or a carbon heater.
- [4] The method of Claim 1, wherein, in the cutting step, the single crystal is formed into a disc shape.
- [5] The method of Claim 4, wherein, after the cutting step, the cut single crystal is formed into a wire by wire-cut electric discharge machining or press machining using a mold having a pattern.
- [6] The method of Claim 4, wherein the disc-shaped single crystal is used as a metal single-crystal substrate or a target for metal deposition.
- [7] The method of Claim 5, wherein the wire formed by the pressing machining is in the form of a ring.
- [8] The method of Claim 1, wherein, in the cutting step, the single crystal is formed into a cylindrical shape.
- [9] The method of Claim 8, wherein the cylindrical single crystal formed in the cutting step is cut into a ring shape.
- [10] The method of Claim 1, which further comprises, after the cutting step, the step of polishing or wet-etching the single crystal.
- [11] The method of Claim 5, wherein the wire is covered with synthetic resin on the outer surface thereof.
- [12] The method of Claim 11, wherein the synthetic resin is covered with natural leather on the outer surface thereof.
- [13] The method of Claim 11 or 12, wherein both ends of the wire are provided with terminals.
- [14] A single crystal wire manufactured by: heating and melting at least one metal selected from the group consisting of gold, copper, silver, aluminum and nickel; growing a single crystal using the metal crystal as a seed by the Czochralski or

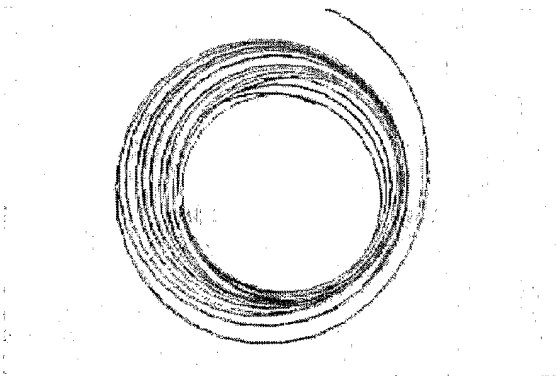
Bridgman method; and cutting the grown single crystal.

- [15] The single crystal wire of Claim 14, wherein the cut single crystal is formed into a ring shape.
- [16] The single crystal wire of Claim 14, wherein the cut single crystal is formed into a wire shape for use as a connection cable.
- [17] The single crystal wire of Claim 16, wherein the connection cable formed into the wire shape is covered with synthetic resin on the outer surface thereof.
- [18] The single crystal wire of Claim 17, wherein the synthetic resin is covered with natural leather on the outer surface thereof.
- [19] The single crystal wire of Claim 17 or 18, wherein both ends of the connection cable are provided with terminals.

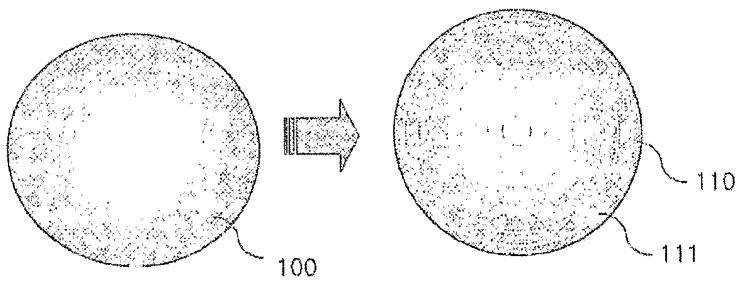
[FIG.1]



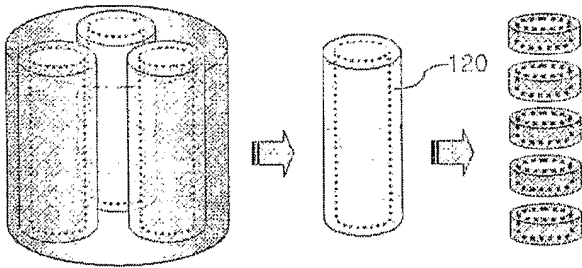
[FIG.2]



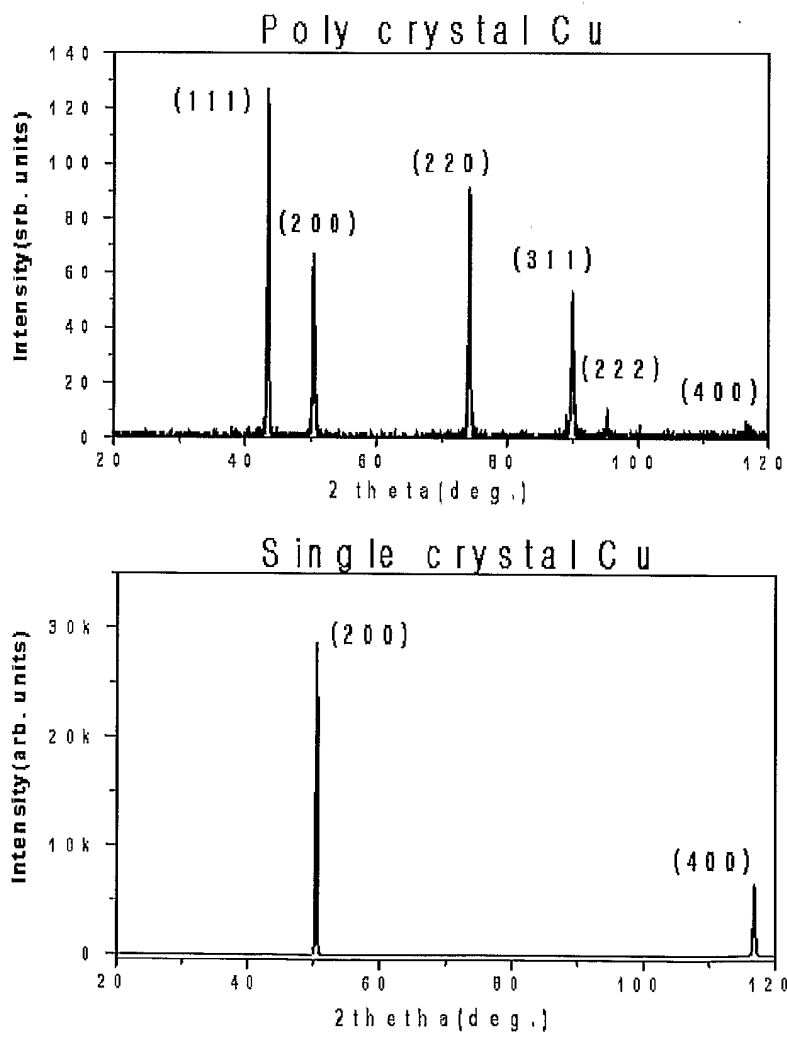
[FIG.3]



[FIG.4]



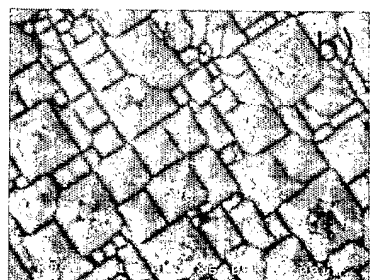
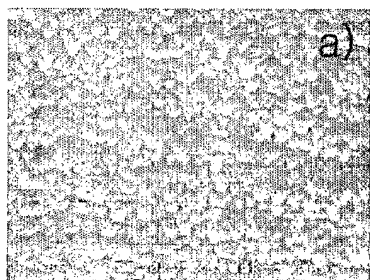
[FIG.5]



[FIG.6]

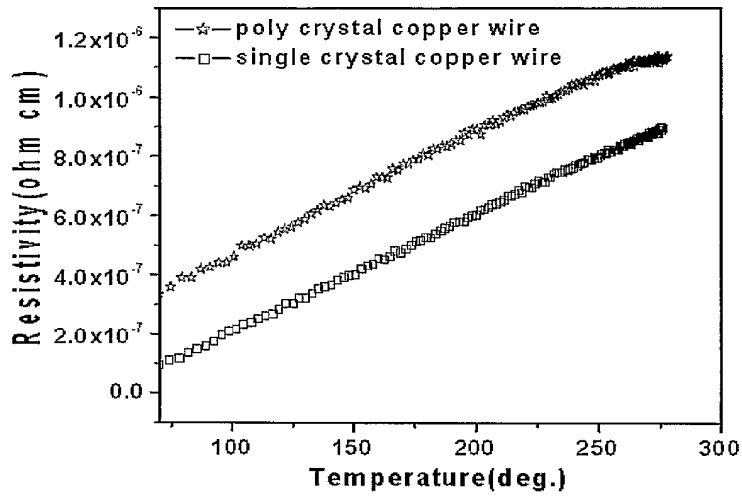
Element	poly crystal Cu	single crystal Cu	
Cu-325	BAL.	BAL.	
Ag-328	0.009645	0.001162	
Al-396	0	0.00189	
As-189	0.00362	0	
Cd-229	0	0	
Co-345	0.000085	0	
Cr-425	0	0	
Fe-372	0.006113	0.000062	
Mg-382	0.00111	0.000711	
Mn-403	0	0	
Ni-341	0.006418	0	
P-178	0.06452	0.00102	
Pb-220	0.03608	0	
S-181	0.00554	0.00044	
Sb-207	0.004905	0.00267	
Se-196	0.00029	0	
Si-288	0.00046	0.00163	
Sn-318	0.02602	0.00204	
Zn-335	0.01047	0	

[FIG.7]

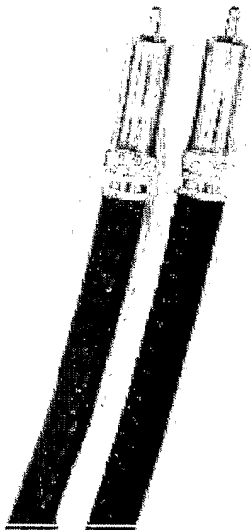


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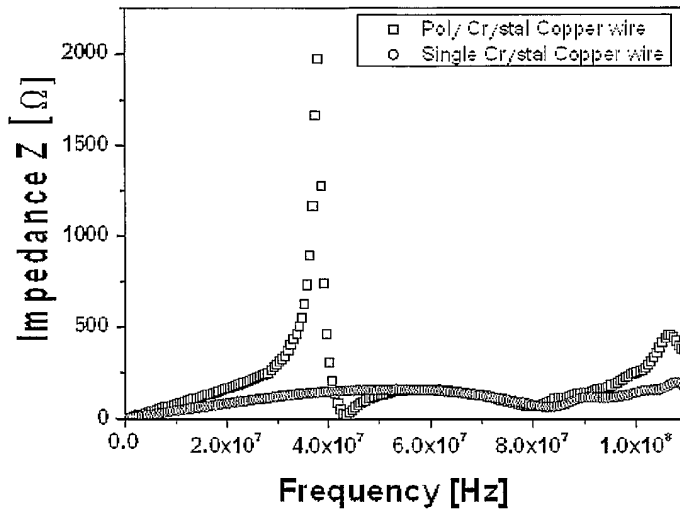
[FIG.8]



[FIG.9]



[FIG.10]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2005/003050**A. CLASSIFICATION OF SUBJECT MATTER****IPC7 C30B 15/00**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 B21C 1/00, C30B 15/00, C30B15/30, C30B 29/30, C30B 35/00

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

Korean Utility models and applications for Utility models since 1975
Japanese Utility models and application for Utility models since 1975

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

eKIPASS(KPA, PAJ, FPD, USPATFULL) in KIPO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 60-092011(SUMITOMO ELECTRIC IND. LTD.) 23 May 1985 see the whole document	1, 14 2-13, 15-19
A	US 5827366 (NEC Corporation) 27 October 1998 see column 1 line 14 - column 2 line 11	1-19
A	US 5667585 (Shin-Etsu Chemical Co., Ltd.) 16 September 1997 see the whole document	1-19
A	JP 61-146796 (SHIN ETSU CHEM CO LTD.) 4 July 1986 see the whole document	1-19
A	US 6315827 (Komatsu Electronics Metals Co., Ltd.) 13 November 2001 see column 1 line 15 - column 3 line 47	1-19

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

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search

27 DECEMBER 2005 (27.12.2005)

Date of mailing of the international search report

28 DECEMBER 2005 (28.12.2005)

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Telephone No. 82-42-481-8153



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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