(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 September 2014 (25.09.2014)

(10) International Publication Number
WO 2014/147872 A1

(51) International Patent Classification:
C04B 35/26 (2006.01) *C04B 35/45* (2006.01) *G21F 1/06* (2006.01)

(21) International Application Number:
PCT/JP2013/075966

(22) International Filing Date:
18 September 2013 (18.09.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2013-057194 19 March 2013 (19.03.2013) JP
PCT/JP2013/058893 19 March 2013 (19.03.2013) JP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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

WO 2014/147872 A1

(54) **Title**: MOLDED BODY FOR STRUCTURE CONSTRUCTION AND MOLDED BODY FOR STRUCTURE CONSTRUCTION MANUFACTURING METHOD

(57) **Abstract**: To present a molded body for structure construction such as a brick or a tile and the like and is a molded body for structure construction brick that is suitable for use for the construction of radiation shielding structures. A molded body for structure construction in which by firing clay into which ferrite powder has been mixed included at a proportion of 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and the radiation shielding effect has been enhanced is obtained. It is preferable that press molding be carried out with the previously mentioned molding material and the compression strength of the molded body for structure construction made 100 MPa or greater. In addition, for the ferrite powder, it is preferable that one that is expressed by the compositional formula: $AO \cdot nX2O_3$ (however, it should be noted that in said compositional formula, A is one type or more of an element selected from among Mg, Ca, Mn, Co, Ni, Cu, Sr, Ba, or Pb, X is one type or more of an element selected from among Fe, Co, or Ni, and n is a mol ratio that is defined as an integer from 1 to 9) be used.

DESCRIPTION

MOLDED BODY FOR STRUCTURE CONSTRUCTION AND MOLDED BODY FOR STRUCTURE CONSTRUCTION MANUFACTURING METHOD

Field of Industrial Utilization

[0001] The present invention relates to a molded body for structure construction such as a brick or tile and the like and in particular to a molded body for structure construction that is suitable for use for the construction of radiation shielding structures effect, and a manufacturing method for the molded body for structure construction.

Background of the Invention

[0002] The insufficiency of the temporary storage facilities for the waste materials that have been contaminated with radioactive substances following a nuclear power plant accident has become a problem. It is desirable that temporary storage facilities for waste that has been contaminated with radioactive substances be surrounded by a wall formed with highly dense concrete so as to shield the radiation that is emitted from said waste materials. However, when a wall is to be formed with concrete, it is necessary to go through the series of operations of (1) setting up a form, (2) arranging rebar in the form, (3) pouring the concrete into the form, (4) curing the concrete, and (5) removing the form, and there is a problem that this entails work, time, and cost. In addition, there is the problem that the cold and sterile appearance of the concrete is a blot on the landscape. These problems are one of the reasons that the construction of temporary storage facilities for the waste materials that have been contaminated with radioactive substances has not advanced.

[0003] In contrast to this, molded bodies for structure construction such as bricks, tiles, and the like have advantages such as the fact that construction can be done simply by only laying one on top of another without the need for a formwork, or by bonding them together, the appearance after construction is favorable, and they are widely employed. However, because, in general, the density of molded bodies for structure construction is low at around 2.2 g/cm^3, a satisfactory radiation shielding effect as an enclosure for the temporary storage facilities described above cannot be expected. For example, if one were to use bricks and make an enclosure for the temporary storage facilities, it is necessary for the bricks to be stacked in multiple layers or to increase the thickness of each individual brick and, in fact, there is a risk of running into higher costs. It would be advantageous if there were molded bodies for structure construction such as bricks and the like that have a high density and that have a strong radiation shielding effect but that kind of item is not to be found.

[0004] Incidentally, a technology has been proposed to increase the density and raise the radiation shielding effect by having concrete and the like contain ferrite (for example, refer to Patent References 1 and 2). Ferrite is a kind of magnetic material that contains oxides of iron and is something that is widely used in various kinds of electronic components such as motor magnets, toner drums for copy machines and laser printers, magnetic disks, magnetic tapes, and the like. In the case of the radiation shielding material of Patent References 1 and 2, the focus is on the high density (radiation shielding effect). However, nothing is cited in Patent References 1 and 2 regarding having ferrite included in molded bodies for structure construction such as bricks and the like nor is this even suggested. Molded bodies for structure construction such as bricks and the like and concrete have commonality in that both are employed as construction materials but the production methods (in particular, the existence or nonexistence of firing), the materials (composition), the forms, the construction methods, and the like differ and they are completely different things.

[0005] In addition, in Patent Reference 3, a brick or tile has been proposed in which a plurality of ceramic materials that contain ferrite have been laminated and fired. However, the brick of Patent Reference 3 is one in which the focus is not on the density possessed by the ferrite but rather on the electromagnetic characteristics the ferrite has and does not go beyond the aim of shielding the electromagnetic waves that are emitted from mobile telephones and personal computers. In other words, nothing is cited in Patent Reference 3 regarding increasing the density of the brick or tile and enhancing the radiation shielding effect nor is this even suggested.

Prior Art References

Patent References

[0006] <Patent Reference 1> Japanese Laid-Open Patent Application Publication (Kokai) Number 57-016397 [(page 2, upper right field, lines 8 through 15 and page 2, lower right field, lines 16 through 20)]

<Patent Reference 2> Japanese Laid-Open Patent Application Publication (Kokai) Number 2002-267792 (Claims)

<Patent Reference 3> Japanese Laid-Open Patent Application Publication (Kokai) Number 2008-094066 (Claims, and paragraphs 0002, 0005, 0030, and 0033)

Summary of the Invention

Problems of Prior Art To Be Solved by the Invention

[0007] The present invention is one that was done in order to solve the problems described above and presents a molded body for structure construction such as a brick or a tile and the like and is a molded body for structure construction that can be suitably used to construct a radiation shielding structure. Specifically, the present invention has as its object the provision of a molded body for structure construction, the density of which is great, that exhibits a superior radiation shielding effect, and that is high strength. In addition, an object of the present invention is to construct a radiation shielding structure easily and in a short period of time, and to minimize the construction cost. In addition, an object of the present invention is also to improve the appearance of the radiation shielding structure that has been constructed and to maintain the scenic view of the environs of said radiation shielding structure. Furthermore, an object of the present invention is also to present a manufacturing method for the molded body for structure construction described above.

Means To Solve the Problems of Prior Art

[0008] The problems described above are solved by presenting a molded body for structure construction the characteristics of which are that the density after firing (the density that has been measured by the vacuum method in "Measurement method for the apparent porosity, coefficient of water absorption, and specific gravity of a fire resistant brick" of "JIS R2205-1992" in which a sample of a molded body for structure construction has been cut to 100 mm L, 100 mm W, and 100 mm H with a diamond cutter after firing; hereinafter referred to as "molded body bulk density after firing"; the same hereafter in this Specification) is made 3.5 g/cm^3 or greater and the radiation shielding effect has been enhanced by firing the molding material in which ferrite powder is contained at a proportion of 60 wt% or greater after forming into a specified shape, and by presenting a manufacturing method for the molded body for structure construction. Here, the meaning of "a molded body for structure construction" is not something that is cast on-site such as concrete and the like but is a material used for structure construction that has been molded in a specified shape beforehand. As examples that can be given of molded bodies for structure construction, there are those such as bricks and tiles and the like with which shielding structures such as walls, ceilings, floors, and the like are formed in structures by stacking, assembling, and bonding a plurality of individual items.

[0009] By including the ferrite powder and firing in this manner, it is possible to increase the bulk density of the molded body after firing and provide a molded body for structure construction that exhibits a superior radiation shielding effect. Accordingly, the radiation shielding structures, which are needed to shield radiation, such as structures for surrounding temporary storage facilities for the waste materials that have been contaminated with radioactive substances and the like, can be constructed easily and in a short period of time. In addition, it is possible for the appearance of the structure that has been constructed to have an ambience and to not be a blot on the landscape. Furthermore, as has already been discussed, ferrite is employed in various kinds of electronic components. Because of this, waste materials that contain ferrite are produced in the manufacturing processes or the disposal process and the ferrite that is collected from the waste materials can be utilized as the raw material, promoting the efficient utilization of the waste material.

[0010] In the molded body for structure construction and the manufacturing method for this of the present invention, it is preferable that the previously mentioned molded body be press molded and that the compression strength of the molded body for structure construction that is obtained be 100 MPa or greater. By this means, the strength of the molded body for structure construction is further increased and it is possible to construct a structure that is more superior in strength such as earthquake resistance and the like. In addition, the radiation shielding effect can also be increased. The compression strength of the molded body for structure construction of the present invention that contains ferrite powder at proportion of 60 wt% or more can be even further increased to 160 MPa or greater. In addition, as will be discussed later, this can be further increased to 200 MPa or greater, 250 MPa or greater, and 300 MPa or greater depending on the press molding conditions. In contrast to this, the compression strength of common molded bodies for structure construction that do not contain ferrite is 35 to 50 MPa. As will be discussed later, the higher the compression strength of the molded body for structure construction is made, the greater the bulk density of the molded body after firing and the greater it becomes possible to make the radiation shielding effect. There is no particular upper limit for the compression strength of the molded body for structure construction but realistically, it is around 400 to 500 MPa.

[0011] The type (the compositional formula) of the ferrite powder in the molded bodies for structure construction of the present invention and the manufacturing method for this are not particularly restricted as long as the bulk density of the molded body can be made 3.5 g/cm^3 or more after firing but usually, the one that is employed is expressed by

compositional formula: $AO \cdot nX_2O_3$.

However, it should be noted that in the aforementioned compositional formula, n is a mol ratio that is defined as an integer from 1 to 9.

[0012] In addition, in the aforementioned compositional formula, A is one type or more element selected from among magnesium (Mg), calcium (Ca), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), strontium (Sr), Barium (Ba), or lead (Pb) but, in particular, one type or more of an element selected from among Sr, Ba, or Pb is preferable. This is because the atomic numbers (mass number) of Sr, Ba, and Pb are large compared to other elements and these exhibit a more superior radiation shielding effect.

[0013] Furthermore, in the aforementioned compositional formula, X is one type or more of an element selected from among iron (Fe), cobalt (Co), or nickel (Ni) but Fe is particularly preferable. Fe is low cost compared to Co or Ni and is practical.

[0014] With regard to the type of molding material into which the ferrite powder is mixed in the molded body for structure construction and the manufacturing method for this of the present invention, there are no particular restrictions as long as the material is something that can be used as the raw material for molded bodies for struction construction. For clay, one that has one type or more of an oxide selected among alumina (Al_2O_3), silica (SiO_2) or boron oxide (B_2O_3) as a primary component is illustrative. Specifically, kaolinite ($Al_2Si_2O_5(OH)_4$), halloysite ($Al_2Si_2O_5(OH)_4 \cdot 2H_2O$), and the like can be given as examples.

[0015] In addition, with regard to the molded body for structure construction firing temperature and the mold body for structure construction firing time and the manufacturing method for this of the present invention, these differ depending on the type of molding material and of the ferrite powder that is mixed into the material as well as the balance between the firing temperature and the firing time and the like and there are no particular restrictions. However, when the melting point of the ferrite that is contained in the molded body for structure construction and the strength of the molded body for structure construction that is obtained are taken into account, the firing temperature of the molded body for structure construction is usually set at 1,000 to 1,400° C and the firing time is usually set at 50 to 150 hours.

[0016] Furthermore, there are no particular restrictions regarding the particle diameter of the ferrite powder in the molded body for structure construction of the present invention and the manufacturing method for this. However, when the ease of ferrite powder manufacture, the ease of mixing the ferrite powder with the clay, and the moldability of the clay after the ferrite powder has been mixed in are taken into account, the particle diameter of the ferrite powder is usually made from 0.5 μm to 8 mm. Unexpectedly, within this range, fine particle diameters of between .5μm and 20μm, even when comprising 95% of the ceramic body by weight, resulted in fired ceramic bodies with the highest specific gravity, and had no problems with cracking or dimensional accuracy. These results run counter to ceramics industry teachings which underscore the extreme importance of using a wide and mixed distribution of granule size in ceramic body. See, e.g., Easy to Understand Industrial Ceramics, pages 99-102/516; ; Author: Youichi Shiraki; Published Gihodo Shuppan Co. Ltd., 1-3-6, Akasaka, Minato Ward, Tokyo, June 30, 1969.

Advantageous Result of the Invention

[0017] As discussed above, in accordance with the present invention, for a molded body for structure construction such as a brick or a tile and the like, it is possible to present a molded body for structure construction that can be suitably used for the construction of radiation shielding structures. Specifically, it is possible to present a molded body for structure construction in which the bulk density of the molded body after firing is high and that not only exhibits a superior radiation shielding effect but also demonstrates a high degree of strength. In addition, a radiation shielding structure for shielding radiation can be constructed easily and in a short period of time and the construction cost can also be minimized. Furthermore, it is possible to improve the appearance of the radiation shielding structure that has been constructed and to maintain the scenic view of the environs of said radiation shielding structure. Moreover, the manufacturing method for the molded body for structure construction described above can also be presented.

Preferred Embodiments of the Invention

[0018] Summary of the brick of the present invention and a manufacturing method for this. A further specific explanation will be given regarding preferred embodiments of the molded body for structure construction of the present invention and of the manufacturing method for this. The molded body for structure construction of the present invention is one that is produced going through

(1) a molding material production process in which the molding material that contains ferrite powder at a proportion of 60 wt% or more is produced,

(2) a molding process in which the molding material that has been obtained in the modling material production process is formed into a specified shape, and

(3) a firing process in which the molding material that has been molded into a specified shape in the molding process is fired.

A molded body for structure construction in which the bulk density of the molded body after firing of 3.5 g/cm^3 or more, which is considerably higher than the bulk density of the molded body after firing of an ordinary molded body for structure construction (around 2.2 g/cm^3) and that exhibits a superior radiation shielding effect can be made.

[0019] Incidentally, radiation is classified by the propagation form, the wavelength (energy), the generation origin, and the like into particle radiation such as alpha (α) rays, beta (β) rays, neutron rays, and the like, and electromagnetic waves such as gamma (γ) rays, X rays, and the like. With the molded body for structure construction of the present invention it is possible to shield all of the radiation given above but among these, shielding of γ rays and X rays, which have strong penetrability, has been assumed. Because γ rays and X rays do not have an electrical charge and are electrically neutral, it is not possible to attenuate them by means of electromagnetic interaction. For the shielding of γ rays and X rays, the use of a high density material is essential and the molded body for structure construction of the present invention can exhibit a superior effect with regard to shielding γ rays and X rays.

[0020] Detailed explanations will be given below regarding the preferred embodiments of the molded body for structure construction of the present invention and of the manufacturing method for this in the order of the processes described above. For convenience in the explanations below, the illustrations will be given for examples of the case where a brick is produced as the molded body for structure construction but methods modeled on these can be employed in the case of the production of other molded bodies for structure construction such as tiles and the like.

[0021] 1. Molding material production process

The molding material production process is a process in which the molding material that includes the ferrite powder at 60 wt% is produced. In the present preferred embodiment, this becomes a mixing process in which the molding material is produced by adding clay to the ferrite powder and missing. For the ferrite powder, an item that has been crushed and pulverized after mixing iron oxide (Fe_2O_3) and various kinds of additives with such materials as strontium carbonate ($SrCO_3$), barium carbonate ($BaCO_3$), and the like and granulating and firing, is used. In addition, ball clay, which is a type of kaolinite is used.

[0022] In this preferred embodiment, the mixture proportion of the ferrite powder is not particularly limited as long as the proportion is 60 wt% or more. However, when increasing the bulk density of the molded body after firing for the molded bodies for structure construction that are obtained and enhancing their radiation shielding effect as well as increasing the strength of the molded bodies for structure construction are taken into account, it is preferable that the mixture proportion of the ferrite powder be made as high as possible. Specifically, a mixture proportion for the ferrite powder of 70 wt% or more is preferable, 80 wt% or more is more preferable, and 85 wt% or more is even more preferable. On the other hand, if the ferrite powder mixture proportion is made too high, the mixture proportion of the material that has plasticity that is efficacious for molding such as clay inevitably becomes low, the plasticity of the molding in an unfired state is degraded, and it becomes difficult to form said molding material into the specified shape. Because of this, in the case of mixing with a material that has plasticity such as clay, the mixture proportion of the ferrite powder is made 97 wt% or less. However, it should be noted that when a binder such as an organic binder is used and the ferrite powder is bonded, molding is possible without mixing in clay and the like. Because of this, in those cases where a binder is used, the mixture proportion of the ferrite powder can be higher than the case described above. Specifically, it is possible for the mixture proportion (the content) to be 100% or to approach 100% without limit.

[0023] In addition, the particle diameter of the ferrite powder that is mixed into (included in) the molding material is, as discussed above, usually made 0.5 μm to 8 mm. However, if the particle diameter of the ferrite powder is too small, time and effort for crushing is required. Because of this, it is preferable that the particle diameter of the ferrite powder be made 1 μm or greater, 2 μm or greater is more preferable, and 3 μm or greater is even more preferable. On the other hand, if the particle diameter of the ferrite powder is too large, there is a risk that molding of the molding material to which the powder has been added will become difficult. In addition, there is also a chance that it will be difficult to mix in the ferrite powder uniformly. Because of this, it is preferable that the particle diameter of the ferrite powder be made 8 mm or less, 4 mm or less is more preferable, and 2 mm or less is even more preferable. In the present preferred embodiment, the particle diameter of the ferrite powder is made 0.5 to 20 μm with an average value of around 5 μm. It has unexpectedly been discovered that within those ranges pre-fired ceramic bodies that are comprised of 60 or more percent (by weight) of particles between .5μm and 20μm are viable and have the highest specific gravity. See below Effects of Ferrite Granule Size Distribution on Specific Gravity in Fired Ceramic Bodies, Compounds A-D. Moreover, those comprising ferrite with average particle diameters of between 3 and 600 micrometers, inclusive, are most preferred. Thus, in a preferred embodiment, the ceramic body comprises ferrite powder with at least 60% of the ceramic body's weight due to particles between .5μm and 20μm in size, more preferably at least 70% of its weight; still more preferably, at least 80% of its weight; still more preferably, at least 90% of its weight; and most preferably, at least 95% of its weight. Although less desirable, a relatively narrow mix of particle size between .5μm and 600μm may also beneficially account for at least 60% of ceramic body weight; more preferably, at least 70%; still more preferably, at least 80%; still more, at least 90%; and most preferably, at least 95%. The average ferrite particle diameter is preferred to be between 3 and 600 micrometers, inclusive. The resultant fired ceramic body most preferably has a compressive strength of greater than 150 MPa and a density of greater than 3.5 g/cubic cm.

[0024] If the waste substances that are obtained when products that contain ferrite (electronic components such as the magnets for motors, toner drums for copy machines and laser printers, magnetic disks, magnetic tape, and the like) are manufactured, or when the waste materials that are produced when said products are disposed of are used for the ferrite powder, the efficient utilization of waste materials can be planned for.

[0025] 2. Molding process

When the molding material production process described above has finished, the molding process is carried out next. The molding process is a process in which the molding material into which the ferrite powder has been mixed in the molding material production process (mixing process) is formed into a specified shape. The molding material molding method is not particularly restricted but this is preferable that this be carried out by press molding using a press machine. If, at this time the press molding is carried out under a vacuum (under reduced pressure; vacuum pressing), the molding material will be made dense, the bulk density of the molding material after firing of the molding material (the molded body for structure construction) will be further increased, and it is possible to obtain a molded body for structure construction that exhibits a more superior radiation shielding effect. In addition, it becomes possible to further increase the compression strength of the molded body for structure construction that is obtained.

[0026] The shape and dimensions that the molding material is molded into are suitably determined in conformance with the application and the like of the molded body for structure construction. For example, when the molded body for structure construction is used as a brick and the like, examples that can be given include a rectangular parallelepiped (including a cube or a quadrilateral plate), a cylinder (including a disk), a shape that combines these, and the like. In addition, in those cases where the molded body for structure construction is used as a tile, floor, ceiling, or roof material (roofing tile and the like), examples that can be given include a thick plate or a shape in which this has been curved. In those cases where inserting rebar through the inside of the molded body for structure construction is anticipated, it is possible to form a pass though hole or a groove for threading the rebar or a screw and the like. A design on the molded body for structure construction such as the formation of patterned indentations and the like can be applied to the surface of the molding material after molding. In this manner, the shape of the molding material can be appropriately determined in conformance with the application for the molded body for structure construction and the like.

[0027] 3. Firing process

When the molding process described above has finished, the firing process is carried out next. The firing process is a process in which the molding material that has been formed into a specified shape in the molding process is fired. The firing temperature for the molding material is, as discussed above, usually 1,000 to 1,400° C. However, if the firing temperature for the molding material is made too low, there is a chance that the molding material cannot be satisfactorily fired and the molding material (the molded body for structure construction) will be easily broken after firing. Because of this, it is preferable that the firing temperature for the molding material be made 1,100° C or above and 1,200° C or above is more preferable. On the other hand, if the firing temperature for the molding material is too high, there is a danger that the clay or the ferrite powder that the molding material contains will melt and shape of the molding material will not be able to be maintained. Because of this, it is preferable that the firing temperature for the molding material be made 1,350° C or below. In the present preferred embodiment, the firing temperature for the molding material is made 1,280° C (about 1,300° C).

[0028] In addition, the firing time for the molding material is, as discussed above, usually 5 to 150 hours. However, if the firing time for the molding material is too short, there is a chance that the molding material cannot be satisfactorily fired and the molding material (the molded body for structure construction) will be easily broken after firing. Because of this, it is desirable that the firing time for the molding material be made long at 10 hours or more 30 hours or more, or 50 hours or more. It is preferable that the molding material firing time be made 60 hours or more, 70 hours or more is more preferable, and 80 hours or more is optimal. On the other hand, if the firing time for the molding material is too long, there is a danger that shrinkage due to the firing will be intensified and the dimensional accuracy will be degraded. Because of this, it is preferable that the firing time for the molding material be made 150 hours or less and 130 hours or less is more preferable. In the present preferred embodiment, the firing time for the molding material (the time from insertion into the firing furnace (tunnel kiln) until removal) is made 120 hours.

[0029] 4. Completion

When the firing process described above has finished, the molded body for structure construction is completed. The bulk density of the molding material for the molded body for structure construction after firing is 3.5 g/cm^3 or more and is considerably high compared to that of a molded body for structure construction such as an ordinary brick and the like. Because of this, the molded body for structure construction of the present invention is one that can exhibit a superior radiation shielding effect compared to an ordinary molded body for structure construction. In addition, the molded body for structure construction of the present invention has a high degree of strength compared to an ordinary molded body for structure construction.

[0030] It is preferable that the bulk density of the molding material of the molded body for structure construction after firing be made as high as possible in order to further increase the radiation shielding effect and the strength of the molded body for structure construction that is obtained. Specifically, it is preferable that the bulk density of the molding material of the molded body for structure construction after firing be 3.8 g/cm^3 or more, 4.0 g/cm^3 or more is more preferable, 4.2 g/cm^3 or more is even more preferable, 4.3 g/cm^3 or more is even more preferable, 4.4 g/cm^3 or more is even more preferable, and 4.5 g/cm^3 or more is optimal. In the molded body for structure construction of Working Example 7 discussed later, the bulk density of the molding material after firing is made 4.58 g/cm^3. If a scheme such as the vacuum press discussed above is applied to the molding of the molded body for structure construction, it is possible to make the bulk density of the molding material after firing greater than this. On the other hand, the upper limit of the bulk density of the molding material of the molded body for structure construction after firing is not particularly limited but barring the mixing of a material having a greater density than ferrite powder into the molding material, making the density greater than the density of ferrite powder (usually, around 4.6 to 5.1 g/cm^3) is not possible.

<u>Working Examples</u>

[0031] 5. Evaluation of the radiation shielding effectiveness

The molded bodies for structure construction of Working Examples 1 through 9 and the molded bodies for structure construction of Comparative Examples 1 and 2 were fabricated in order to investigate the radiation shielding effect of the molded body for structure construction of the present invention. Together with this, the molded bodies for structure construction of Comparative Examples 3 and 4 were procured and the evaluation of radiation shielding effectiveness was carried out for each of the respective molded bodies for structure construction. For the molded bodies for structure construction of Working Examples 1 through 9 and of Comparative Examples 1 and 2, after a molding material in which strontium • ferrite ($SrO \cdot 6Fe_2O_3$), barium • ferrite ($BaO \cdot 6Fe_2O_3$), ball clay (kaolinite), boric acid ($B(OH)_3$), N3 (an item in which a molding material comprising a mixture of crushed fired clay and raw clay is press molded and fired; the composition is 64 wt% of silica (SiO_2), 32 wt% of alumina (AL_2O_3), and 2 wt% of iron oxide (III) (Fe_2O_3)), and chromite ($FeCr_2O_4$) or manganese (Mn) that were combined as shown in Table 1 below had been press molded, firing was done for 120 hours at a firing temperature of 1,280° C.

[0032] In addition, in Table 1 below, the figures that are underlined indicate that they are an outer percentage. Furthermore, in the "Pressing Conditions" of Table 1 below, "A" means a "50 t press (done once)," "B" a "150 t press (done once)," "C" a "300 t press (done eight times)," and "D" a "300 t press (done six times)." For the 50 t press, a Mitsuishi Fukai Iron Works Co., Ltd. pipe press system (model: PS70) was used, for the 150 t press, a Mitsuishi Fukai Iron Works Co., Ltd. friction press system (model: F150T), and for the 300 t press, a Mitsuishi Fukai Iron Works

Co., Ltd. vacuum press (model: CFOP-1E). For the press mold, one 230 mm L x 114 W x H (varied with the powder fill volume) was used for all. Because of this, the press pressure became about 18.7 MPa in the case of the 50 t press, about 56 MPa in the case of the 150 t press, and 112 MPa in the case of the 300 t press.

[0033] As the molded bodies for structure construction of Comparative examples 3 and 4, which are not entered in Table 1 below, the molded body for structure construction of Comparative Example 3 is an ordinary commercially available brick (a brick that does not contain ferrite) and the molded body for structure construction of Comparative Example 4 is a commercially available cement brick (a cement brick that does not contain ferrite). For reference purposes, the component fractions of the strontium • ferrite in the aforementioned Table 1 were measured using a Rigaku Corp. X-ray fluorescence spectrometer (model: ZSX100e) and are entered in Table 2 below. In addition, the bulk density and the compressed density of the molding material after firing of the molded bodies for structure construction of Working Examples 1 through 9 and of the molded bodies for structure construction of Comparative Examples 1 through 4 are listed in Table 3 below. For the compressed density in Table 3 below, a Tokyo Testing Machine, Inc. compression strength testing apparatus (No. 212445) was used and the measurements were done in conformance with the "fire resistant brick compression strength test method" of "JIS R2206." Looking at and comparing Table 1 and Table 3 below, the bulk density of the molding material after firing becomes greater as the press pressure when the molding material is molded is made greater and it can be ascertained that the compression strength also become greater.

[0034] Table 1

	W.E. 1	W.E. 2	W.E. 3	W.E. 4	W.E. 5	W.E. 6	W.E. 7	W.E. 8	W.E. 9	C.E. 1	C.E. 2
Strontium • ferrite	90	87	–	95	95	95	95	95	100	10	25
Barium • ferrite	–	–	90	–	–	–	–	–	–	–	–
Ball clay	10	10	10	5	5	5	5	5	–	–	–
Boric acid	–	3	–	–	–	–	–	–	–	–	–
N3	–	–	–	–	–	–	–	–	–	90	75
Chromite	–	–	–	–	–	–	–	–	–	2	–
Manganese	–	–	–	–	–	–	–	–	–	1.8	–
Press cond.	A	A	A	A	A	B	C	D	C	A	A

[0035] Table 2

Component	Content Percentage (wt%)
Fe_2O_3	88.4
SiO_2	0.01
SrO	10.9
Al_2O_3	0.04
Na_2O	0.01
TiO_2	0
MnO	0.31
BaO	0.12
K_2O	0.01
CaO	0.02
ZrO_2	0
Cr_2O_3	0.05
P_2O_5	0.01
SO_3	0.03
MgO	0.01
NiO	0.02
V_2O_5	0
Cl	0.01

[0036] Table 3

	Bulk Density of the Molding Material After Firing (g/cm^3)	Compression Strength (MPa)
Working Example 1	4.20	234
Working Example 2	4.16	228
Working Example 3	4.23	238
Working Example 4	4.01	214
Working Example 5	3.90	165
Working Example 6	4.57	324
Working Example 7	4.58	265
Working Example 8	4.39	249
Working Example 9	4.78	347
Comparative Example 1	2.30	47.2
Comparative Example 2	2.60	64.5
Comparative Example 3	2.10	36.9
Comparative Example 4	2.00	24.3

[0037] <Photosensitivity Test>

First, the evaluation of the radiation shielding effect of the molded bodies for structure construction of Working Examples 1 through 3 and the molded bodies for structure construction of Comparative Examples 1 through 4 was carried out by means of the following photosensitivity test. That is to say, with radiation sensitive film ("X-ray film for industrial use IX100" made by Fuji Film) spread on the bottom of each of the molded bodies for structure construction of Working Examples 1 through 3 and the molded bodies for structure construction of Comparative Examples 1 through 4, the sensitivity (the depth of black in a monochrome image) after irradiation of the top surface of each molded body for structure construction with radiation for a fixed period of time was measured for each respective film. The dimensions of the molded bodies for structure construction used in the photosensitivity tests were made identical in Working Examples 1 through 3 and Comparative Examples 1 through 4 and the thicknesses (the thickness in the direction of radiation penetration) were made uniform at 60 mm. For the measurement of the depth of the black of the film a densitometer ("Sakura Densitmeter PDA-81" made by Konica Minolta) was used. Two types of radiation, X rays and γ rays were employed. The radiation source for the γ rays was ^{192}Ir. Because the greater the radiation shielding effect of the molded body for structure construction, the smaller the amount of radiation that reaches the film and there is no sensing (change in color from white to black) by the film, the figure for the depth that was measured by the previously mentioned densitometer is small. The figures of the depth for the films for the molded bodies for structure construction of Working Examples 1 through 3 and the molded bodies for structure construction of Comparative Examples 1 through 4 and the when each was irradiated with X rays and γ rays respectively are shown in Table 4 below.

[0038] Table 4a

	Film Depth After X Ray Irradiation	Film Depth After γ Ray Irradiation
Working example 1	0.7	0.9
Working example 2	0.6	0.8
Working example 3	0.4	0.8
Comparative example 1	3.8	1.5
Comparative example 2	2.8	1.5
Comparative example 3	4.5	1.7
Comparative example 4	4.5	1.7

[0039] However, it should be noted that the value for the film depth in the aforementioned Table 4a is the dimensionless quantity D that is calculated using Equation 1 given below. In Equation 1 below, L_0 is the brightness (cd/m^2) of the observation light with which the film is irradiated from the observation light irradiation section in the previously mentioned densitometer, and L is the brightness (cd/m^2) of the reflected light that the film reflects and that is received by the light receptor section of the previously mentioned densitometer.

<Expression 1>

$$D = \log_{10} (L_0/L) \qquad \text{… Equation 1}$$

[0040] Looking at the aforementioned Table 4a, the film depths in the case where the molded bodies for structure construction of Comparative Examples 3 and 4, which do not contain ferrite, were irradiated with X rays were both 4.5 and the film depths in the case of irradiation with γ rays of the molded bodies for structure construction in the same Comparative Examples 3 and 4 were both 1.7. On the other hand, although the film depths (2.8 and 3.8) in the case where the molded bodies for structure construction of Comparative Examples 1 and 2, which were given a ferrite content of 10 and 25 wt%, were irradiated with X rays were to some degree reduced from that of the film depths (4.5) in the case where the molded bodies for structure construction of Comparative Examples 3 and 4, which did not contain ferrite, the film depths (1.5) in the case where the molded bodies for structure construction of Comparative Examples 1 and 2 were irradiated with γ rays was almost no reduction from the film depths (1.7) in the case where the molded bodies for structure construction of Comparative Examples 3 and 4 were irradiated with γ rays. From this fact, it became clear that although with the molded bodies for structure construction of Comparative Examples 1 and 2, which were given a ferrite content of 10 and 25%, a certain shielding effect is ascertained with regard to X rays compared to the molded bodies for structure construction of Comparative Examples 3 and 4, which do not contain ferrite, almost no shielding effect is ascertained with regard to γ rays.

[0041] In contrast to this, the film depths (0.4 to 0.7) in the case where the molded bodies for structure construction of Working Examples 1 through 3, which contain 87 to 90 wt% of ferrite were irradiated with X rays, are a reduction to approximately one-tenth compared to the film depth (4.5) in the case where the molded bodies for structure construction of Comparative Examples 3 and 4, which do not contain ferrite, were irradiated with X rays. In addition, the film depths (0.8 to 0.9) in the case where the molded bodies for structure construction of Working Examples 1 through 3, which contain 87 to 90 wt% of ferrite were irradiated with γ rays, are a reduction to approximately one-half compared to the film depth (1.7) in the case where the molded bodies for structure construction of Comparative Examples 3 and 4, which do not contain ferrite, were irradiated with γ rays. From this fact, it became clear that the molded bodies for structure construction of Working Examples 1 through 3, which contain 87 to 90 wt% of ferrite, exhibit a considerably superior shielding effect compared to the molded bodies for structure construction of Comparative Examples 3 and 4 with regard to both X rays and γ rays.

[0042] As shown below, a number of Examples have a compressive strength much greater than ordinary ceramic body.

[0043] Table 4b

		Practice Example 4	Practice Example 5	Practice Example 6	Practice Example 7	Practice Example 8	Practice Example 9
	Strontium Ferrite	95	95	95	95	95	100
	Barium Ferrite						
	Ball Clay	5	5	5	5	5	
	Boric Oxide						
	N3						
	Chromite						
	Manganese						
	Pressing Method	B	C	D	A	A	D
	Specific Gravity (g/cm^3)	4.57	4.58	4.39	4.01	3.9	4.78
Attenuation Length by gamma-ray transmission test (cm^{-1})	137Cs, 0.662 MeV	0.345	0.355	0.338	0.308	0.260	0.385
	60Co, 1.173MeV	0.275	0.274	0.263	0.241	0.210	0.293
	60Co, 1.332MeV	0.258	0.261	0.252	0.227	0.228	0.277
	Compressive Strength (MPa)	324.3	265.8	249.4	214	165.4	334.7

[0044] <γ Ray Penetration Test>

Next, the radiation shielding effect of the molded bodies for structure construction of Working Examples 1 through 9 described above was evaluated by the measurement of the attenuation coefficient μ with a γ ray penetration test. For the γ ray penetration test, 10 cm square plate test samples of the molded bodies for structure construction of Working Examples 1 through 9 were each adjusted to a thickness of 1 cm. For the measuring device, a low-background pure germanium semiconductor detector manufactured by Canberra (Canberra GC1520) was used. The analysis of the measurement results was carried out by the evaluation of the integrated intensity of the spectrum using line analysis software, "wPK area 2006."

For the standard radiation source, Cs-137 (8.10E +03 Bq) and Co-60 (4.32E +03 Bq), which are the γ ray standard radiation sources of the Japan Radioisotope Association, were used. The values of the attenuation coefficient μ that were obtained using the γ ray penetration test are shown in Table 5 below.

[0045] Table 5

	Attenuation Coefficient μ Using the γ Ray Penetration Test (cm^{-1})		
	Cesium 137 0.662 MeV	Cobalt 60 1.173 MeV	Cobalt 60 1.332 MeV
Working Example 1	0.317	0.252	0.241
Working Example 2	0.314	0.243	0.238
Working Example 3	0.320	0.257	0.238
Working Example 4	0.308	0.241	0.227
Working Example 5	0.260	0.210	0.228
Working Example 6	0.345	0.275	0.258
Working Example 7	0.355	0.274	0.261
Working Example 8	0.338	0.263	0.252
Working Example 9	0.385	0.293	0.277
Comparative Example 5	0.317	0.252	0.241
Comparative Example 6	0.314	0.243	0.238

[0046] However, it should be noted that the values of the attenuation coefficient μ of Working Examples 1 through 9 in Table 5 above have been calculated using Equation 2 below. In

Equation 2, I_0 is the figure for the count of the case in which the measurement has been done in a state where the plate test samples comprising the molded bodies for structure construction are not present and I is the figure for the count of the case in which the measurement has been done in a state where each of the plate test samples comprising the molded bodies for structure construction of Working Examples 1 through 9 has been set in place. In addition, x is the thickness (cm) of each of the plate test samples comprising the molded bodies for structure construction of Working Examples 1 through 9.

<Expression 2>

$$\mu = (1/x) \log_e (I_0/I) \quad \text{. . . Equation 2}$$

[0047] In addition, for reference purposes, the reference values that are cited in the "Shielding calculation practice manual for radiation facilities" (written, edited, and published by: Nuclear Safety Technology Center, Law Concerning Prevention of Radiation Injury Due to Radioisotopes, Etc., Publishing and Editing Committee; printing and binding: Sobunsha Co., Ltd., published March 2007) have been used. The attenuation coefficient of lead (molded body bulk density, 11.34 g/cm^3), which was calculated in accordance with the calculation method cited in the reference document, was made Comparison Example 5 and the attenuation coefficient of concrete (molded body bulk density 2.1 g/cm^2 [sic]) was made Comparison Example 6, and are shown in Table 5 below [sic].

[0048] Looking at Table 5 above, the fact that in all of the cases of "Cesium 137 0.662 MeV," "Cobalt 60 1.173 Mev," and "Cobalt 60 1.332 Mev," the attenuation coefficients μ are greater and a more superior radiation shielding effect is exhibited for the molded body for structure construction of Working Example 6 in which press molding was done with a 150 t press (done once), the molded bodies for structure construction of Working Examples 7 and 9 in which press molding was done with a 300 t press (done eight times), and the molded body for structure construction of Working Example 8 in which press molding was done with a 300 t press (done six times), than for the molded bodies for structure construction of Working Examples 1 through 5 in which press molding was done with a 50 t press (done once) was ascertained. In particular, the fact that the molded bodies for structure construction of Working Examples 6 through 9 having a bulk density of the molded body after firing that is 4.3 g/cm^3 or greater and, moreover, a compression strength that is roughly 250 MPa or greater exhibit a more marked radiation shielding effect than the molded bodies for structure construction other than these of Working Examples 1 through 5 was ascertained. Among these, the molded body for structure construction of Working Example 9 exhibits a conspicuous radiation shielding effect. From this, it was ascertained that in order to increase the radiation shielding effect, it is desirable that the press pressure at the time of molding the molding material be increased increasing the bulk density and the compression strength of the molding material after firing. In addition, it was ascertained that although the radiation shielding effect of the molded bodies for structure construction of Working Examples 1 though 9 falls short of that of lead (Comparison Example 5), which is a metal, the effect is quite superior to that of concrete (Comparison Example 6), which is used as a construction material when building radiation shielding structures.

[0049] 6. Applications

With regard to the molded bodies for structure construction of the present invention, there are no particular restrictions concerning their application but, as described above, because they exhibit an extremely superior radiation shielding effect, it is possible for them to be appropriately employed in applications where shielding of radiation is required (the construction of radiation shielding structures (including buildings)). In particular, they can be suitably used in applications that shield radiation having strong penetrating power such as X rays, γ rays, and the like. In addition, because with the molded bodies for structure construction of the present invention construction can be carried out easily and in a short period of time, they can be suitably used in applications for which immediacy is needed. For example, it is possible for them to be suitably employed as molded bodies used for radiation shielding structure construction where structures for the enclosure of temporary storage facilities for the waste materials that have been contaminated with radioactive substances are built. It is anticipated that by using the molded bodies for structure construction of the present invention, the insufficiency of the temporary storage facilities for the waste materials that have been contaminated with radioactive substances following a nuclear power plant accident, which has become a problem, can be resolved.

[0050] Effects of Granule Size Distribution on Specific Gravity in Fired Ceramic Bodies

[0051] A series of tests were conducted to determine the effect of granule size distribution on the specific gravity of fired ceramic body. Surprisingly, all tested ranges were found to be viable, but with the best results for the finest, least diverse ranges of particle distribution.

[0052] a. Compound A

-0.6mm Sr-ferrite grain: 47.5%

Average Particle Diameter (APD): 1.19μm; range between .5μm and 20μm

Sr-ferrite powder: 47.5%

Ball Clay: 5%

Mecellose: 0.2%

Lignosulfonate: 0.5%

Water: 1.5%

[0053] b. Compound B

0.6-2.0mm Sr.-ferrite grain: 47.5%

Sr-ferrite powder: 47.5%

Ball Clay: 5%

Mecellose: 0.2%

Lignosulfonate: 0.5%

Water: 1.5%

[0054] c. Compound C

2.0mm-Sr-ferrite grain: 47.5%

Sr-ferrite powder: 47.5%

Ball Clay: 5%

Mecellose: 0.2%

Lignosulfonate: 0.5%

Water: 1.5%

d. Compound D

Sr-ferrite powder: 95%
Ball clay: 5%
Mecellose: 0.2%
Lignosulfonate: 0.5%
Water: 1.5%

] Result: Specific gravities of burned bodies are listed below.

Compound A: 4.15g/cm3
Compound B: 3.58 g/cm3
Compound C: 3.45 g/cm3
Compound D: 4.58 g/cm3

Conclusions: There was apparent inverse correlation between particle size and burning shrinkage ratio, and consequently, between particle size and specific gravity. Fired ceramic bodies with near exclusively fine (.5μm to 20μm) ferrite particles were viable even when the particles account for up to 95% of pre-firing ceramic body weight. Further experiments have found that an average pre-firing ferrite particle diameter of greater than 3 micrometers but less than 600 micrometers is preferred. In the range of .98 micrometers to 3.8 micrometers for average pre-firing ferrite particle size, the larger the average pre-firing ferrite particle size, the greater the specific gravity of the fired ceramic body. But this trend was not true, as shown above, for average pre-firing ferrite particle sizes of greater than 600 micrometers. The most preferred fired ceramic bodies contain ferrite according to the foregoing embodiments and methods and have specific gravities of greater than 3.8 g/cubic centimeters and compressive strength of greater than 150 MPa.

Claims

1. A molded body for structure construction characterized in that by firing moding material in which ferrite powder has been included at a proportion of 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^{3}and the radiation shielding effect has been enhanced.

2. The molded body for structure construction cited in Claim 1 in which the previously mentioned molding material is press molded and the compression strength has been made 100 MPa or greater.

3. The molded body for structure construction in Claim 1 or 2 in which the ferrite powder is one that is expressed by

the compositional formula: AO • nX_2O_3 (however, it should be noted that in said compositional formula, A is one type or more of an element selected from among Mg, Ca, Mn, Co, Ni, Cu, Sr, Ba, or Pb, X is one type or more of an element selected from among Fe, Co, or Ni, and n is a mol ratio that is defined as an integer from 1 to 9).

4. The molded body for structure construction cited in Claim 3 in which A in the previously mentioned compositional

formula is one type or more of an element selected from among Sr, Ba, or Pb.

5. The molded body for structure construction cited in Claim 3 or 4 in which X in the previously mentioned compositional formula is Fe.

6. The molded body for structure construction cited in any of the Claims 1 through 5 in which the molding material is one that contains clay that has one type or more of an oxide selected from among Al_2O_3, SiO_2, or B_2O_3 as a primary component.

7. The molded body for structure construction cited in any of the Claims 1 through 6 in which the firing temperature is 1,000 to 1,400° C and the firing time is 5 to 150 hours.

8. The molded body for structure construction cited in any of the Claims 1 through 7 in which the particle diameter of the ferrite powder is 5 μm to 8 mm.

9. A brick comprising the molded body for structure construction cited in any of the Claims 1 through 8.

10. A manufacturing method for a molded body for structure construction characterized in that a molded body for structure construction is obtained with which by firing

molding material in which ferrite powder has been included at a proportion of 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 $g/cm^3$and the radiation shielding effect has been enhanced.

11. A ceramic body, comprising firing clay and ferrite powder wherein 60% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size, and the density after firing is at least $3.5 g/cm^3$.

12. The ceramic body cited in Claim 11 in which the particles' composition is expressed by the compositional formula: $AO \cdot nX_2O_3$. A is one type or more of an element selected from among Mg, Ca, Mn, Co, Ni, Cu, Sr, Ba, or Pb, X is one type or more of an element selected from among Fe, Co, or Ni, and n is a mol ratio that is defined as an integer from 1 to 9.

13. The ceramic body cited in Claim 11 in which A in the previously mentioned compositional formula is one type or more of an element selected from among Sr, Ba, or Pb.

14. The ceramic body cited in Claim 12 or 13 in which X in the previously mentioned compositional formula is Fe.

15. The ceramic body cited in any of the Claims 11 through 14 in which the clay is one that has one type or more of an oxide selected from among Al_2O_3, SiO_2, or B_2O_3 as a primary component.

16. The ceramic body cited in any of the Claims 11 through 15 in which the firing temperature is 1,000 to 1,400° C and the firing time is between 3 and 150 hours.

17. The ceramic body cited in any of the Claims 11 through 15 wherein 70% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

18. The ceramic body cited in any of the Claims 11 through 15 wherein 80% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

19. The ceramic body cited in any of the Claims 11 through 15 wherein 90% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

20. The ceramic body cited in any of the Claims 11 through 15 wherein 95% or more of the ceramic body's weight

before firing is due to particles between .5μm and 20μm in size.

21. A ceramic body, comprising firing clay and ferrite powder wherein 60% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size, and the density after firing is at least $3.5g/cm^3$.

22. The ceramic body cited in Claim 21 in which the particles' composition is expressed by the compositional formula: $AO \cdot nX_2O_3$. A is one type or more of an element selected from among Mg, Ca, Mn, Co, Ni, Cu, Sr, Ba, or Pb, X is one type or more of an element selected from among Fe, Co, or Ni, and n is a mol ratio that is defined as an integer from 1 to 9.

23. The ceramic body cited in Claim 22 in which A in the previously mentioned compositional formula is one type or more of an element selected from among Sr, Ba, or Pb.

24. The ceramic body cited in Claim 22 or 23 or 11 in which X in the previously mentioned compositional formula is Fe.

25. The ceramic body cited in any of the Claims 21 through 24 in which the clay is one that has one type or more

of an oxide selected from among Al_2O_3, SiO_2, or B_2O_3 as a primary component.

26. The ceramic body cited in any of the Claims 21 through 25 in which the firing temperature is 1,000 to 1,400° C and the firing time is between 3 and 150 hours.

27. The ceramic body cited in any of the Claims 21 through 25 wherein 70% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

28. The ceramic body cited in any of the Claims 21 through 25 wherein 80% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

29. The ceramic body cited in any of the Claims 21 through 25 wherein 90% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

30. The ceramic body cited in any of the Claims 21 through 25 wherein 95% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

31. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 60% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

32. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 60% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

33. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 70% or more of the ceramic body's weight

before firing is due to particles between .5µm and 20µm in size.

34. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 70% or more of the ceramic body's weight before firing is due to particles between .5µm and 600µm in size.

35. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 80% or more of the ceramic body's weight before firing is due to particles between .5µm and 20µm in size.

36. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5

g/cm^3 and wherein 80% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

37. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 90% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

38. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 90% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

39. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a

specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 95% or more of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

40. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein 95% or more of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

41. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein at least 95% and less than 98% of the ceramic body's weight before firing is due to particles between .5μm and 20μm in size.

42. A manufacturing method for a ceramic body characterized in that a ceramic body is obtained with which by firing clay into which ferrite powder has been mixed at a

proportion of at least 60 wt% after being formed into a specified shape, the density after firing has been made 3.5 g/cm^3 and wherein at least 95% and less than 98% of the ceramic body's weight before firing is due to particles between .5μm and 600μm in size.

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2013/075966

A. CLASSIFICATION OF SUBJECT MATTER
INV. C04B35/26 G21F1/06 C04B35/45
ADD.

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)
C04B G21F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H11 219811 A (SHIBATA TOKI KK; KURANTSU KK; KYOSHIN SHOJI CO LTD) 10 August 1999 (1999-08-10) paragraph [0032] - paragraph [0047]	1-8, 10-42
X	JP 2008 094066 A (UNIV HOKKAIDO; KITAMI INST TECHNOLOGY; HOKKAIDO RYOKAKU TETSUDO KK) 24 April 2008 (2008-04-24) cited in the application paragraphs [0033], [0051] - [0057]	1-3, 5-12, 14-22, 24-42
X	JP 2002 338339 A (FDK CORP) 27 November 2002 (2002-11-27) paragraph [0017] - paragraph [0060]	1,2, 6-11, 15-21, 25-42

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 December 2013	11/12/2013

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2013/075966

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 197 25 869 A1 (SAMSUNG ELECTRO MECH [KR]) 4 June 1998 (1998-06-04) the whole document	1-42

INTERNATIONAL SEARCH REPORT

Information on patent family members

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