from 100 nm to 500 nm inclusive should occupy 70% or more of the entire metal-salen complex. If the particle diameter of the metal-salen complex exceeds 1 μm, there is a possibility that the metal-salen complex may not be able to pass through the capillary vessels. If the particle diameter of the metal-salen complex is less than 100 nm, the ferromagnetic property required for magnetic guidance would not be sufficient.

[Citation List]

[Patent Literature]

[0005]

[PTL 1] WO2008/001851

[PTL 2] WO2012/086683

[Summary of Invention]

[Problems to be Solved by the Invention]

[0006]

However, as a result of earnest examination by the inventors of the present application, it was found that the magnetic property of the metal-salen complex is not determined only by the crystal particle diameter, but is significantly influenced by a stereo structure of metal-salen complex molecules.

[0007]

Therefore, it is an object of the present invention to clarify the structure of a ferromagnetic metal complex and provide a magnetic substance capable of reliably exhibiting the ferromagnetic property by having that structure.

[Means for Solving the Problems]

[0008]

The inventors of the present ~~invention~~ disclosure analyzed a crystal structure of a metal complex organic substance and analyzed the magnetic property of the metal complex organic substance from the viewpoint of its structure. As a result of such analysis, they found that the following matters are important for the metal complex organic substance to exhibit the ferromagnetic property.

[0009]

(1) The metal complex organic substance is structured so that a heterocyle is bonded (for example, by means of coordination) to metal as an active site to exhibit the ferromagnetic property of metal complex organic molecules.

[0010]

decreases, and the magnetization rate decreases.

[0013]

So, as a result of examination of the metal complex compound crystal by the inventors of the present application by means of X-ray analysis, it was found that regarding the metal complex organic compound having the structure in which the heterocycle molecule is bonded to the metal as an active site to exhibit the ferromagnetic property, the metals of two metal complex molecules are bonded together via the electron donor having the electron pair donated to the metals and, furthermore, the bond angle which forms metal - electron donor – metal bonding is within the range from 130° to 160°, so that the stability and the ferromagnetic property of the crystal structure of the metal complex compound are balanced at a higher dimension.

[0014]

Therefore, in one aspect, there is provided a ferromagnetic substance composed of a crystal of a metal complex molecules in which a heterocycle is bonded to metal, wherein the metal of the metal complex molecule is bonded to the metal of another metal complex molecule via oxygen as an electron donor; and wherein the ferromagnetic substance has a ferromagnetic property balanced with stability of the crystals based on a metal - electron donor - metal bond angle that is from 130° to 160°.

In another aspect, there is provided a drug containing, as its principal component, a crystal of a metal complex molecule in which a heterocycle is bonded to metal, wherein the metal of the metal complex molecule is bonded to the metal of another metal complex molecule via an electron donor and the crystal has a ferromagnetic property based on a metal – electron donor – metal bond angle that is from 130°to 160°; wherein the metal complex molecule is a metal-salen complex molecule; wherein the electron donor is oxygen; wherein a distance between the metal and the oxygen is from 1.1 Å to 1.8 Å; and wherein the drug can be applied to an affected site by an external magnetic field.

~~Therefore, the present invention is~~Also disclosed is a magnetic substance containing a metal complex compound composed of a plurality of metal complex molecules in which a heterocycle is bonded to metal, wherein the metal of the metal complex molecule is bonded to the metal of another metal complex molecule via an

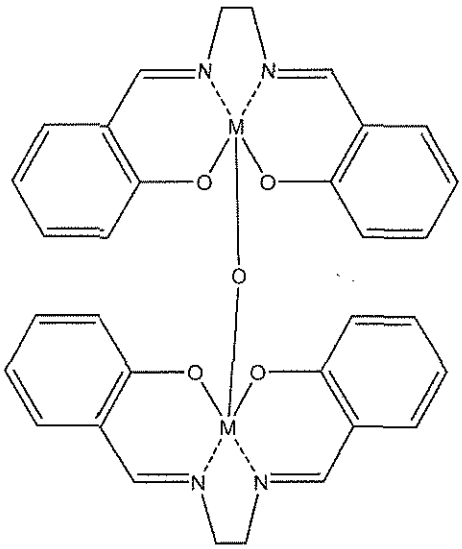
electron donor and a metal - electron donor - metal bond angle is from 130° to 160°, preferably from 140° to 150°, more preferably from 144° to 147°, and most preferably 146.359°.

[0015]

The heterocyle of the iron-salen complex molecule is a cyclic structure formed of two nitrogen atoms and two oxygen atoms which surround an iron (metal) atom in a flat form.

[0016]

The plurality of metal complex molecules, particularly, two metal complex molecules, whose bond angle is formed within the above-mentioned range have high structural stability and high unpaired electron density and are thereby ferromagnetic. When the bond angle formed by the metal - electron donor - metal exceeds 160°, the structural stability of the crystal increases, but the unpaired electron density of the metal complex compound decreases and the magnetization rate decreases; and when the bond angle is less than 130°, the magnetization rate of the metal complex molecules increases, but the stability of the crystal decreases. Incidentally, in the latter case, the magnetization rate of the metal complex molecules increases, but the



[0024]

The metal complex molecule of the present ~~invention~~ disclosure includes derivatives of the metal-salen complex in Chem. 1 (not only molecules in which other functional groups are connected instead of hydrogens as side chains, but also a composite in which the metal-salen complex and another medicinal compound are bonded together (WO2010/058280) may be included). Incidentally, the magnetic substance of the present invention is used not only for magnetic drugs (such as anti-cancer drugs) mentioned earlier, but also for known usage, for example, as magnetic materials for electric and electronic parts, such as switching elements, or as contrast media for MRI.

[Advantageous Effects of Invention]

[0025]

A magnetic substance capable of reliably exhibiting the ferromagnetic property can be provided according to the present invention.

[Brief Description of Drawings]

[0026]

[Fig. 1] Fig. 1 is a perspective view of an iron-salen complex compound single crystal based on structure data of the iron-salen complex compound single crystal;

[Fig. 2] Fig. 2 is a molecular formula representing an iron atom spin orientation of a ferromagnetic substance (iron-salen complex compound);

[Fig. 3] Fig. 3 is a molecular formula representing an iron atom spin orientation of a diamagnetic substance 1 (iron-salen complex compound); and

[Fig. 4] Fig. 4 is a molecular formula representing an iron atom spin orientation of a