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(54) **Composite magnetic material and the method for manufacturing the same**

(57) The method is characterized by the fractions of at least two magnetic powder materials being prepared through sieve analysis, one of these materials being

coarse fractions of magnetic powder (1) coated with insulating or binding dielectric (2), with the other being other fine fractions of non-insulated magnetic powder (3), and the two powders are mixed and cured.

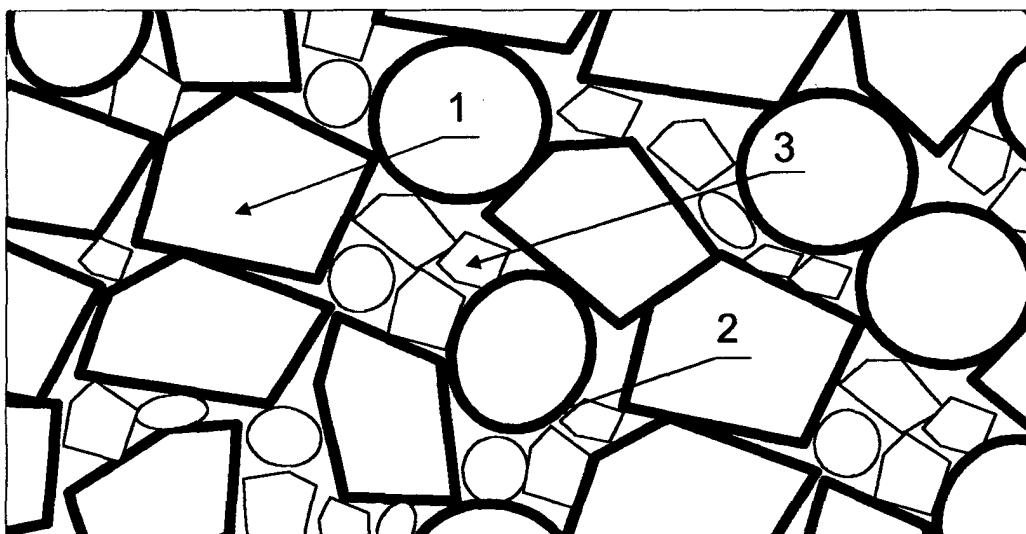


Fig.1.

## Description

**[0001]** This invention concerns the method for manufacturing composite magnetic material and composite magnetic material designed for use in electrical engineering.

**[0002]** Composite magnetic material and the method for manufacturing the same is already known from Polish patent description No. 184856. Magnetic composite material, being electrically conductive elastic solid body of ferromagnetic properties, consists of ferromagnetic particles of magnetically soft materials, favourably chemically pure iron, silicon steel or manganese-zinc ferrite of grain size ranging from 0.1 mm to 0.25mm; particles of electrically conductive substance, favourably of graphite or silver dust of grain size ranging from 0.5 $\mu$ m to 5 $\mu$ m and of non-ferromagnetic, non-electrically conductive binder in the form of elastomer, favourably silicone, wherein virtual resistance of the material equals  $9.2 \times 10^{-5} \Omega$ m to  $5.1 \times 10^{-3} \Omega$ m and virtual Young's modulus equals from 5.6MPa to 5.8MPa. The method of manufacturing composite material consists in the ferromagnetic particles of soft magnetic substances, favourably chemically pure iron silicon steel or manganese-zinc ferrite and particles of electrically conductive substance favourably of graphite or silver dust undergoing intermixing. Then the obtained composition is mixed with a binder in the form of polymer elastomer of paste consistence and it undergoes polymerization in temperature ranging from 18°C to 22 °C.

**[0003]** Method for manufacturing metal powder products, according to which iron-based powder compositions of particles are intermixed with thermoplastic material and lubricant, is known from Polish pattern description No. 179450. The obtained mixture is compacted in temperature under vitrification temperature or thermoplastic resin melting temperature, the compacted product is then heated in order to cure the thermoplastic resin. Subsequently, the compacted ingredient may be thermally treated to the temperature above the temperature of thermoplastic resin curing.

**[0004]** Magnetic particles of intermixed oxides whose group includes ferrites, of particle diameter ranging from 1 to 10nm, proper surface area equaling 120-350 m<sup>2</sup>/g, and with whose surface are the silans with functional groups are connected are already known from Polish patent description No. P 318099. These highly grinded particles can be fabricated through precipitation of mixed oxides from water alkaline solutions in the presence of hydrolysis capable silans, which have hydrolysis-resistant functional groups. These mixed oxides are suitable for being a carrier material attracting organic and biological substances.

**[0005]** Known from use are the composite magnetic materials were compressed magnetic powders, in which all the fractions of the magnetic powder are coated with insulating and binding dielectric.

**[0006]** According to this invention, the essence of the method of manufacturing comprises fraction preparation through sieve analysis of at least two magnetic powder materials, one of which being coarse fraction of magnetic powder coated with insulating and binding dielectric, while the second one is fine fractions of non-insulated magnetic powder.

**[0007]** Sieve analyses of at least two magnetic powder materials using the same sieve, with coarse fractions of the magnetic powder are the powders which are left on the sieve and fine fractions of the magnetic powder are the screened powders, beneficially for sieve analysis of at least two magnetic powder materials the size of the sieve is selected.

**[0008]** The essence of composite magnetic material, according to the invention, is that between the grains of dielectric-coated magnetic powder material's coarse fractions which are coated with insulating and binding dielectric, the filling non-insulated powder fine fractions is placed.

**[0009]** Powder composite material manufactured in this innovative method is characterized by improved magnetic properties in comparison to the composite, in which all the fractions were insulated. Moreover, the new magnetic powder composite material has increased magnetic permeability with maintained total energy loss. The used magnetic powder fractions can be of the same material, and can also be magnetic powders manufactured of different materials.

**[0010]** The object of the invention in the form of method for its manufacture is visible on the drawing, on which Fig. 1 illustrates the schematic structure of composite magnetic material, and Fig. 2 presents maximum permeability characteristics as dependent on the insulated magnetic powder's coarse fractions percentage in the material.

### Example 1.

**[0011]** Method for manufacturing composite magnetic material, wherein the fractions of two magnetic powder materials- 1 and 2 - are prepared through sieve analysis 3. Selected percentage of coarse fractions for composite A equals 25 % wt., with coarse fractions of magnetic powder 1 coated with insulating and binding dielectric 2 being the ones which remain on the sieve of selected size. In case of the second material fine fractions of magnetic powder 3 are the powder screened through the same sieve. Subsequently, powders prepared this method are being mixed and compressed in the temperature below the vitrification temperature, and the compressed product is heated in order to cure the thermoplastic resin. Magnetic material A composite manufactured in such a method is characterized by magnetic permeability  $\mu$  which equals about 350 and is higher in relation to the one of the material manufactured of magnetic powder and coated with insulating and binding dielectric.

## Example 2.

**[0012]** Method of manufacturing composite magnetic material proceeds as above; with the exception that selected coarse fraction percentage for composite B equals 35% wt. and the composite material B manufactured in such a method is characterized by magnetic permeability which equals about 330.

## Example 3.

**[0013]** Method of manufacturing composite magnetic material proceeds as in Example 1, with the exception that selected coarse fraction percentage for composite C equals 50% wt. and the composite material C manufactured in such a method is characterized by magnetic permeability  $\mu$  which equals about 320. Furthermore, fine fractions of magnetic powder 3 are the mixture of different powders.

## Example 4.

**[0014]** Method of manufacturing composite magnetic material proceeds as in Example 1 and 3, with the exception that selected coarse fraction percentage for composite D equals 60% wt. and the composite material D manufactured in such a method is characterized by magnetic permeability  $\mu$  which equals about 300.

## Example 5.

**[0015]** Method of manufacturing composite magnetic material proceeds as in Example 4, with the exception that coarse fraction percentage of magnetic powder 1 comprises a mixture of powders.

## Example 6.

**[0016]** Composite magnetic material being pressed magnetic powders is characterized by the grains of coarse fractions of magnetic powder A is manufactured as in Example 6, with the exception that coarse fraction percentage of magnetic powder 1 comprises a mixture of powders.

## Example 7.

**[0017]** Composite magnetic material manufactured as in example 5, the difference being fine fractions of magnetic powder 3 are the mixture of different powders.

## Example 8.

**[0018]** Composite magnetic material manufactured as in example 5, the difference being fine fractions of magnetic powder 1 are the mixture of different powders.

## Claims

1. Method for manufacturing composite magnetic material, wherein magnetic powders are compacted in temperature below the vitrification or melting temperature of the thermoplastic resin, and the compacted product is heated in order to harden the thermoplastic resin wherein through sieve analysis the fractions of at least two magnetic powder materials are being prepared, one of which are coarse fractions of magnetic powder (1) coated with insulating or binding dielectric (2) and the other fine fractions of magnetic powder (3), and the two powder are being mixed and compacted.
2. Method as claimed in Claim 1, wherein the fractions of at least two magnetic powder materials (1, 3), one of which being coarse fractions of magnetic powder (1) coated with insulating or binding dielectric (2) and the other fine fractions of non-insulated magnetic powder (3).
3. Method as claimed in Claim 1, wherein sieve analyses of at least two magnetic powder materials is conducted using the same sieve, with coarse fractions of the magnetic powder (1) being the powders which are left on the sieve and fine fractions of the magnetic powder (2) being the screened powders.
4. Method as claimed in Claim 1, wherein for sieve analyses of at least two magnetic powder materials (1, 2) the size of the sieve is selected.
5. Composite magnetic material being compacted magnetic powders, wherein between coarse fraction grains of magnetic powder (1) coated with insulating or binding dielectric (2) the filling of other fine fractions of non-insulated magnetic powder (3) is present.

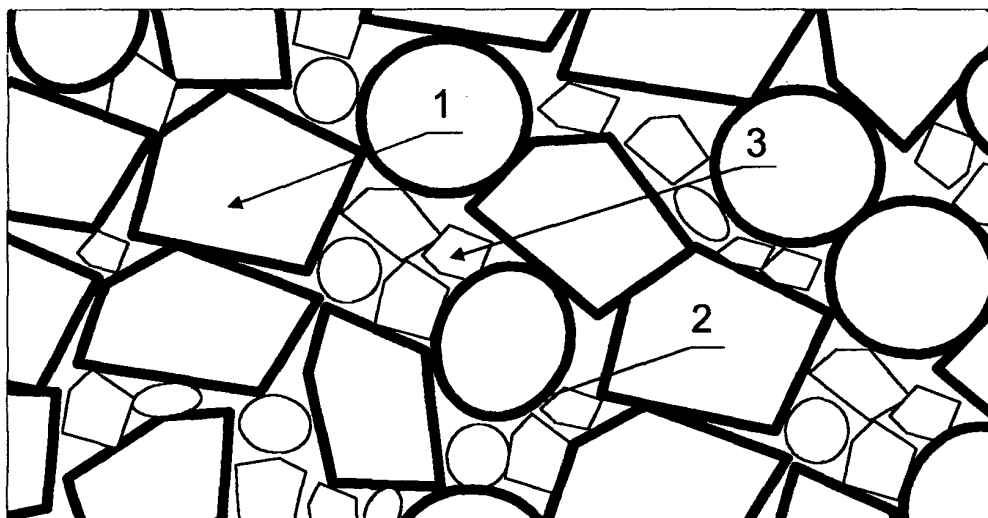


Fig.1.

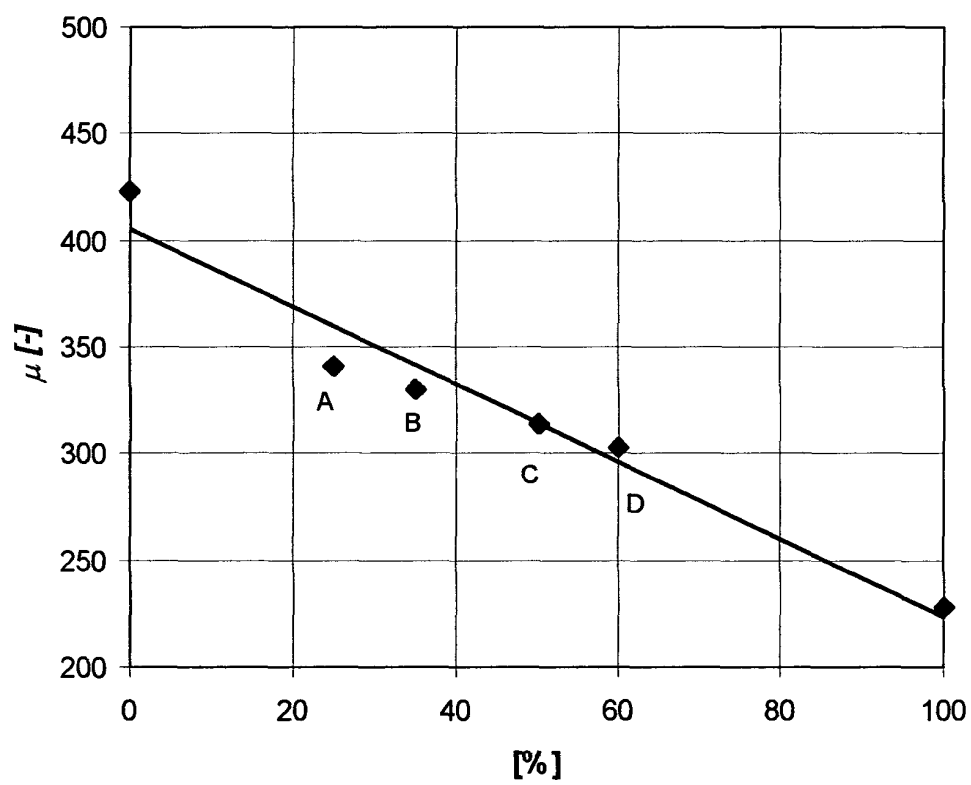


Fig.2.