SINTERED COMPOSITION MATERIAL

Fig. 1

Fig. 2

Fig. 3
SINTERED COMPOSITION MATERIAL

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ABSTRACT OF THE DISCLOSURE

Described is a sintered composition and process for manufacture thereof, for high-duty electrical contacts. The material consists of a silver matrix having fine, evenly distributed metal oxide particles therein together with graphite particles passed from the oxide particles and distributed throughout the matrix. The silver and oxide particles have a grain size below 200 mm, while the graphite particles have a grain size below 10 mm. Exemplary metal oxides are those of cadmium, tin and lead.

SPECIFICATION

Our invention relates to a sintered composition material particularly for high-duty electrical arcing and other switching contacts.

Such contacts are supposed to have a minimum tendency of fusing or freezing when heated by an arc or the passage of electrical current. Preferably used for such purpose are composite contact materials constituted by systems of interbonded metals and metal oxides, preferably those containing silver as the fundamental or matrix substance. Examples of such materials are compositions of silver and cadmium oxide, as well as silver and tin oxide. Also used are contacts composed of metals and metalloids, for example silver and graphite. The known silver-graphite contacts, containing 5 to 10% by weight of graphite, satisfy the requirement of minimal freezing tendency, but are not satisfactory as to other qualities desired of electrical contacts. They suffer excessive wear by burning at the contact faces, and the conductivity of the resulting graphite dust may initiate flashovers in the switching of arcing chambers.

It is an object of our invention to provide a sintered composition material which exhibits the slight fusing or freezing tendency of the graphite-containing material but avoids the danger of causing flashovers, thus also securing the advantages of the metal-oxide compositions. In other words, it is an object of the invention to obviate the disadvantages herefore encountered with all of the above-mentioned known contact materials while preserving their advantages.

To this end, and in accordance with our invention, the sinter-bond composition material is formed of a predominating or fundamental quantity or matrix of silver and contains particles of metal oxide and particles of graphite built into the silver matrix in substantially uniform distribution.

In such sinter-bonded composition materials the metal oxide preferably consists of cadmium oxide or tin oxide. Also suitable is lead oxide. The metal oxides are added to the fundamental or matrix material in a quantity of 3 to 15% by weight, preferably about 10%. For cadmium oxide, this corresponds to 2.7 to 13.3% cadmium. The graphite content is between 1 and 10% by weight. The remainder of the composition may consist substantially all of silver, although minor quantities of good conducting and other metals may be present, no particular purity of the silver or other constituents being required.

The above-mentioned metal oxide, such as cadmium oxide or tin oxide, can be readily obtained in a very fine distribution by internal oxidation of a suitable silver alloy, such as a silver-cadmium alloy. For example, a suitable mixture of silver and cadmium oxide is obtained by heating a silver-cadmium alloy containing about 9% cadmium at a temperature of 600°C in air or oxygen for four hours. This results in producing extremely fine and uniformly distributed segregations of cadmium oxide within a silver matrix.

Contact structures of a particularly good resistance to welding or freezing are obtained if the particle size of the cadmium-oxide segregations is about 1 mm, or also considerably below this value and if the graphite particles embedded in the matrix have a grain size smaller than 10 mm.

A sinter-bonded composition material according to the invention is produced as follows. Powder obtained from silver and metal oxide, produced by internal oxidation of a silver alloy in the manner described above, is comminuted to a grain size below 200 mm, is intimately mixed with graphite powder having a grain size below 10 mm. The mixture is pressed to a structure of the desired shape which is thereafter sintered in nitrogen. Preferably used are 1 to 10% by weight of graphite powder relative to the weight of the mixture of silver and metal oxide powder. Upon sintering the structure may be subjected to afterpressing. When completed, the structure is deburred. Preferably the structure is provided on one side with a layer of silver, which can be readily brazed or hard soldered onto a carrier metal.

The sinter-bonded composition material according to the invention is particularly well suitable for contacts in circuit breakers to operate in air, preferably in motor protective breakers up to 200 amperes rated current. Even under aggravated conditions, such as the switching of motors in starting-up operation or intermittent operation, as well as when switching short-circuit currents, the contact structures made from composition material according to the invention have not resulted in welding or freezing at the contact faces. Such structures, therefore, are especially well suitable for high-duty electrical contacts. Their useful life is sufficiently long and their electrical contact resistance is sufficiently low to satisfy exacting requirements in practice.

The invention will be further described with reference to the accompanying drawings in which:

FIG. 1 is a lateral view of an electric contact containing a composition structure according to the invention; FIG. 2 shows partly in section another electrical contact equipped with a modified form of a structure made according to the invention; and FIG. 3 shows a microphotograph of a section taken from a composition material according to the invention.

Referring to FIG. 1, there is illustrated a contact structure 1 consisting of silver, cadmium oxide and graphite which carries a layer 2 of pure silver joined by silver solder 3 with the metallic carrier 4 of the contact. The metal carrier preferably consists of copper, brass, bronze or the like.

The embodiment shown in FIG. 2 resembles that of FIG. 1, except that the contact structure 1 proper carries on its bottom side a weldable metal layer 5. The illustrated contact is formed by placing the structure 1 with the layer 5 on top of the carrier 4 and then welding both together. The welding, performed for example on a capacitor-pulse welding apparatus, results in melting part of the metal so that, after the welding is completed, there is formed a boundary region 6 which contains an alloy of the two metal components 4 and 5. The weldable metal
of layer 5 is chosen in dependence upon the particular metal, such as copper, brass or bronze, of the carrier 4
and should be suitable for the pulse welding process. Such weldable metals are known and comprise, for ex-
ample, silver-copper alloys and nickel-copper alloys.

The schematic representation of a microphotograph shown in FIG. 3 relates to a section taken through the contact material in a direction perpendicular to the press-
ing direction. The magnification is about 1:100. The mat-
rix 9 of silver is seen to contain very fine and uniformly embedded CdO-particles 7. Also visible are the larger graphite particles 8 embedded in the silver matrix. It will be observed that the embedded CdO particles are spatially separated from the graphite particles. This is the reason why the sintering heat applied to the composition does not cause a reducing reaction between the CdO and the
graphite, so that the two embedded components remain separately preserved within the silver matrix. Predicated upon this phenomenon is the outstanding contact qualities observed, particularly the minimal welding tendency accompanied by slight electrical contact resistance and slight burn-off.

Described in the following are examples relating to the production of sinter-bonded composition materials according to the invention.

Example 1

A quantity of 97 g. of the above-described composition powder consisting of silver and cadmium oxide in the ratio 88/12 and having a grain size remote 200 μm.
were intimately mixed with 3 g. graphite powder of a grain size below 10 μm. The mixture was compressed and shaped at a pressure of 6 m.p. cm.2. The shaped body was sintered for one hour at 800° C. in nitrogen. The resulting sintered body was subsequently pressed at a pressure of 6 to 10 m.p. cm. 2 and deburred by tumbling in a drum. The materials were used in motor protective circuit breakers and were found to prevent freezing up to the highest short-circuit currents occurring in practice. Any fused bridging, as may occur between the contact pieces under severe conditions, could be broken by min-
imal opening forces (below 500 p.s.).

Example 2

A die was partly filled with silver powder up to a pressing height 0.3 mm. Deposited on top of the silver powder was a mixture of the above-mentioned powder composition of silver and cadmium oxide, as well as car-
bon powder in the mixing ratio of 84/12/4, up to a total pressing height of 2.7 mm. The just mentioned values of height relate to the pressed body. The actual filling heights up to which the respective powders reached within the die, were 1 mm. for the silver powder and 2.8
mm. for the powder mixture of Ag-CdO-C. The two layers were jointly pressed at a pressure of 6 m.p. cm. 2 resulting in a pressing density of ρ = 8.3 g. cm-3. The pressed body was sintered at 900° C. in a nitrogen atmo-
sphere for one hour. The sintered body was subse-
sequently pressed at 10 m.p. cm.2 and thereafter deburred by drumming. The pressing density of the subsequent pressing was ρ = 8.7 g. cm-3. The space filling degree was at approximately ε = 0.997 (theoretical density ρth = 8.79 g. cm-3). Obtained in this manner was a two-layer pressed and sintered body. The silver surface of this body could be readily and satisfactorily attached by brazing. Contacts made in this manner were found to be particularly advantageous for use in contactors and other switching devices, including motor protective circuit breakers, up to 200 amps rated current.

Example 3

96 g. powder of silver and tin dioxide (Ag-SnO2) was uniformly mixed with 4 g. graphite whose grain size was less than 10 μm. The Ag-SnO2 powder contained 94% by weight of silver and 6% of SnO2. The powder mixture was filled into a steel die previously provided with a bot-
tom layer of pure silver powder. Both layers were then densified by a pressure of 6 m.p. cm.2 to form an integral shaped body composed of two layers. The pressed body was sintered for one hour at 850° C. in nitrogen. The resulting sintered body was subsequently pressed at a pressure of 8 m.p. cm.2, and thereafter deburred by drumming. The contact structure thus obtained was brazed onto a contact carrier metal with the aid of a hard solder containing 40% silver. The contact material exhibited favorable electric contact properties, particularly in mo-
tor protective circuit breakers up to 200 amps rated cur-
rent, and behaved satisfactorily also when repeatedly sub-
jected to short-circuit current.

We claim:
1. A sintered composition material particularly for high-duty electrical contacts, comprising a matrix of metallic silver and having particles of metal oxide sele-
ected from tin oxide, lead oxide and cadmium oxide, finely and uniformly embedded therein, and graphite particles separately dispersed substantially uniformly throughout the metal oxide containing silver matrix, said silver and oxide particles having a grain size below 200 μm., and said graphite particles having a grain size below 10 μm., said metal oxide forming about 3 to 15% by weight, said graphite about 1 to 10%, and said silver substantially all of the remainder.
2. A sintered composition material according to claim 1, wherein the amount of said metal oxide is approximat-
ely 10% by weight.
3. A sintered composition material according to claim 1, wherein said metal oxide particles are formed substan-
tially of cadmium oxide.
4. A sintered composition material according to claim 3, wherein the cadmium content of the oxide is between 2.7% and 13.3% by weight.
5. A sintered composition material according to claim
3, wherein said cadmium oxide particles have an average grain size below 5 μm., and said graphite particles have a grain size below 10 μm.
6. The method of producing the sintered composition material of claim 1, which comprises forming a mixture of silver powder with a about 3 to 15% by weight of a metal oxide powder selected from tin oxide, lead oxide, and cadmium oxide and about 1 to 10% by weight graphite powder, pressing a shaped body from the mixture, and sintering the body in an inert atmosphere to produce the composition material.

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