The Manufacture of High Permeability Mn-Zn Ferrites by Atmospherical Protect

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J. PHYS. IV FRANCE 7 (1997)
Colloque C1, Supplément au Journal de Physique III de mars 1997

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Abstract: For the manufacture of high permeability Mn-Zn ferrite cores, the zinc loss from the surface of sintering cores causes poor yield rate of final products. This experiment uses the atmospherical protection to reduce the evaporation of zinc. The control of the oxygen partial pressure and flow rate precisely can reduce the zinc loss about 20% to 35%, but it is not enough to get a good distribution of permeability of products, i.e. the distribution of initial permeability from 12000 to 15000 per products about 14% before atmospherical control and 25% after atmospherical control, respectively. Combination with precise control and zinc vapor compensation can increase the yield rate 9% to 15%. Another experiment to manufacture high permeability Mn-Zn ferrite cores for 15000±30% in a batch type furnace(about 13 Kg / batch), is to use a new engineering method to protect sintering core to avoid vaporizing zinc vapor, the yield rate can be rapidly increased from 25% to 75% and the effective capacity of furnace can be at least twofold. It is successful to manufacture homogeneous and high permeability of Mn-Zn ferrites both increasing the quality of products and decreasing the operating costs.

Introduction: The high permeability Mn-Zn ferrites were developed for a long time by Dr. E Roess[1,2], but for mass production of Mn-Zn ferrites, the homogeneily of the products is not so easy to control. The one of the paramount important reasons is the zinc loss from the outer surface of sintering cores which reduces the initial permeability , especially in the high permeability products. It is caused by the zinc vaporized of the surface of sintered cores in the reduced atmosphere, the lower oxygen partial pressure or longer annealing time, the more serious zinc vaporized[3]. It is more sensitive for smaller size high permeability Mn-Zn ferrites than for the variation of composition. So manufacturer must be dispensed extra source to eliminate failure products, and the cost upward.

Experimental: Toroidal samples compounded with Fe_2O_3, $MnCO_3$, ZnO were prepared by conventional powder metallurgy processes. Granulated powders were pressed into two size toroids, T4×2×3 (OD:4mm, ID:2mm, H:3mm) and T9×5×3 (OD:9mm, ID:5mm, H:3mm). Samples were fired in furnace, atmospheric conditions were controlled during cooling to maintain spinel phase equilibrium. In order to observe zinc vaporizing effect, T4×2×3 samples were placed on boat shape sagas, and put into a tube furnace there were ZnO-rich powder inside with different ratio of ZnO/matrix. Beside, we placed T4 ×2×3 cores into T9×5×3 cores to coaxial sintering in the batch type furnace to compare the initial permeability distribution with the T4×2×3 cores sintering alone.

Results and Discussion: It is well known that zinc vaporized from the outer surface of sintering cores will decrease the initial permeability[4,5]. We also discover the different position in the furnace when sintering Mn-Zn ferrite cores, the different level of zinc vaporized, so it is very difficulty to obtain homogeneous characteristics of Mn-Zn ferrites on the manufacture.

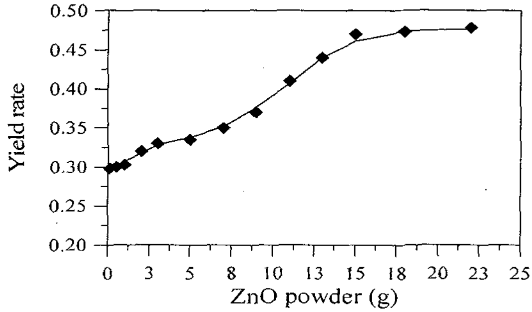

Figure 1 the relationship between the yield rate and the weight of ZnO powder

Figure 1 shows the relationship between the yield rate (μ_i = 15000±30%) and the weight of ZnO powder in the tube furnace. The actual effect of zinc loss is known, so the zinc vapor compensation were offered to reduce zinc vaporized. It is observable that zinc loss were repressed successfully by figure 1. But the yield rate increased from 30% to 47% diminutively, the reason is the bottom and surround of the cores contact with the boat shape saggars. Beside, by the restrictly of the sintering condition, the yield rate isn't increased when ZnO powder is beyond 18 gram. Figure 2(a,b) shows the permeability distribution of T4×2 ×3 cores sintering alone compared with that coaxial sintering with T9×5×3 cores. In figure 2a, the T4×2×3 cores were strewn on the sagas arbitrarily, the permeability distribution peak is smoothly. The cores were exposed in the reduction atmosphere and reaction with saggars are the cause of the random distribution.

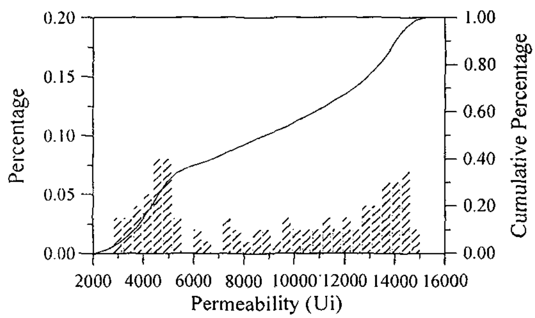

Figure 2a the permeability distribution of T4×2×3 cores sintering alone

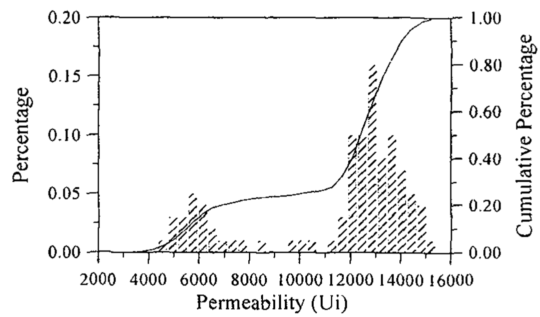

Figure 2b the permeability distribution of T4×2×3 cores coaxial sintering in T9×5×3 cores

Figure 2b shows the permeability distribution of T4×2×3 cores coaxial sintering in T9×5×3 cores. It is found the yield rate is increased promptly from 40% to 75%, the average permeability is also upward. We can consider that the pressure of zinc vapor has achieved equilibrium to avoid the zinc vaporized during the sintering process due to the T4×2×3 cores in T9×5× 3 cores arrangement. But the bottom and top layers remain exposed to the reduction circumstance, so we can find the peaks at low permeability range. The yield rate of T9×5×3 cores sintering alone compared with that coaxial sintering with T4×2×3 cores isn't increased observably, but it is available to enhance the permeability.

Conclusion: By the study, it's found that despite of the decrease of the permeability due to the zinc loss during the sintering process of Mn-Zn ferrites, it is shown that a zinc vapor compensation can raise the yield rate from 30% to 48%. Else, the coaxial sintering method can efficiently increase the yield rate from 30% to 75%, which leads to an improvement of both the quality of Mn Zn ferrite cores and increase the effective capacity of furnace.

Acknowledgments: The authors would like to thank the Ministry of Economic Affairs, Republic of China, for financial support under contract number 3KF2200 to the Industrial Technology Research Institute.

Reference

1.Smit.J. and H.P.J.Wijn, 1959, Ferrites, pp.73-75, Philips Technical Library
2.B.D.Cullity, "Introduction to Magnetic Material", 1972, CH12, pp.443-444
3.S.H.Chen, "Effect of Sintering Parameters on Zn Loss for Preparation of High Permeability MnZn Ferrites", IEEE Trans. Mag. Vol. 28, No. 5, pp.2436-2438(1992)
4.N.J. Hellicar, Ceramic Bulletin, Vol. 61,No. 4 , p.5022 (1982)
5.G. Schnitt, Z. Anorg. Allg. Chem., p.41 (1973)