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PREPARATION OF ELECTRON HIGH TEMPERATURE SUPERCONDUCTORS

Disclosed is a process for obtaining ceramics of electron high temperature superconductors such as $Nd_{1.85}Ce_{0.15}CuO_4$, with macroscopically uniform concentrations of cerium and oxygen that result in bulk superconductors suitable for application.

Ceramic samples of the newly discovered electron superconductors [1] are difficult to prepare with uniform rare earth and oxygen concentration throughout. The materials obtained by the usual procedure of calcining the oxides together at high temperatures yield inhomogeneous samples that show no bulk superconductivity [2].

The procedure described here involves a two-step calcination [3] according to the following reactions:

$$\frac{1}{2}\,Nd_2O_3 + CeO_2 \rightarrow NdCeO_{3.5}$$

$$(1 - x)Nd_2O_3 + xNdCeO_{3.5} + CuO \rightarrow Nd_{2-x}Ce_xCuO_4 + 0.25xO_2\uparrow$$

Step (1) is carried out in a furnace heated to 1400°C for 48 hours in air. The resulting product is ground and mixed with the additional constituents shown in Step (2) and then fired in a furnace at 980°C for 24 hours in flowing oxygen. The product is then reground, pelletized and refired at 1050°C for 48 hours in flowing oxygen. Step (1) forms the known compound $NdCeO_{3.5}$ which is then used in Step (2) to yield the desired product $Nd_{2-x}Ce_xCuO_4$ containing uniformly distributed Ce, and overcomes the problem encountered using the normal one-step procedure. The product is now annealed in flowing argon in a sealed furnace heated to 980°C for 24 hours, then rapidly quenched to room temperature. This invention also claims that the use of argon and a temperature of 980°C is necessary and an improvement over the use of N_2 and 900°C in obtaining optimum superconducting behavior. The result of employing the procedures of this invention is a bulk ceramic superconductor suitable for application.

References

[1] Y. Tokura, H. Takagi and S. Uchida "A Superconducting Copper Oxide Compound with Electrons as the Charge Carriers," Nature 337, 345 (1989).

[2] M. E. Lopez-Morales, R. J. Savoy and P. M. Grant, "Compositional Properties and Thermoelectric Power of the Superconducting Ceramic $Nd_{2-x}Ce_xCuO_{4-y}$," Solid State Communications 71, 1079 (1989).

[3] M. E. Lopez-Morales, R. J. Savoy and P. M. Grant, "The preparatio and processing of bulk superconducting ceramic $Nd_{1.85}Ce_{0.15}CuO_{4-y}$ Journal of Materials Research, Rapid Communications 5, 10, 2041 (October 1990).