Homogeneity field and magnetoresistance of the Ca(Mn,Cu)7O12 solid solution prepared in oxygen

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Abstract

Potential applications of modern colossal magnetoresistive (CMR) materials as magnetic sensors or read heads, for information storage and in spintronics maintain intense research on crystal and local structures, magnetic ordering, and mechanisms of CMR in different manganite compounds. Recently, large MR in perovskite-like CaMn3-xCuxMn4O12 (0 ¡ x ≤ 3) phases was reported. The MR of these compounds shows a higher magnetic field sensitivity at low fields and better thermal stability, which is advantageous for device applications. The temperature and field dependences of the MR in CaMn3-xCuxMn4O12 phases suggest a large contribution of interdomain / intergrain tunneling magnetoresistance (TMR). In general, the magnitude of TMR depends on the microstructure, particularly, on the grain size, mutual particle orientation and the area of intergrain boundaries. Optimization of all of these properties requires novel preparation and processing techniques. Typically, Ca-Mn-Cu-O phases are synthesized under high oxygen pressures (0.18 50 kbar) in evacuated silica tubes or autoclaves. These techniques do not allow facile preparation of these compounds with optimized properties. Therefore, we considered alternative preparation strategies. In our group CaMn3-xCuxMn4O12 solid solution (0 ≤ x ≤ 1.5) was prepared in pure oxygen at 850C and ambient pressure. The compound was synthesized either with KCl, added as a mineralizer to precursors, or annealing the mechanically activated oxide precursor. These synthetic methods allowed optimization of the microstructure of the samples to reproducibly yield the record negative magnetoresistance of -65% at 35К in a field of 5Т, for x = 1.0.