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Growing and characterization of $YBaCo_4O_{7+\delta}$ thin films on (1022)-oriented sapphire substrates.

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Abstract – Successful growth of thin films of the novel cobaltite $YBaCo_4O_{7+\delta}$ on (1022)-oriented sapphire substrates is reported. This is the first time that this novel cobaltite is produced in form of thin film. Samples were fabricated using dc sputtering system working at high oxygen pressures. Films were characterized after their structural, morphological and electrical properties. X-ray diffraction analysis showed textured growth of the films on the sapphire substrates. Measurements of the resistivity as a function of the temperature revealed semiconducting character of the as grown films. No indication of transitions was detected in the measuring temperature range (50-300 K).

Recently, Co-based compounds have intensively been investigated due to the existence of intriguing magnetic properties [1]. The most representative element of such cobalt oxide systems is the spinel Co_3O_4 which features antiferromagnetic ordering [2]. Recently, the new type of ceramic compound $YBaCo_4O_7$, denoted 114, was reported to exhibit an unusual magnetic behavior, which resembled that of a spin-glass [3] phase. Also, the structure itself seems to be a geometrically frustrated system, which has a unique magnetic substructure. Certainly, the $YBaCo_4O_7$ lattice comprises layers formed by two different types of cobalt-oxygen tetrahedral, $(Co1)0_4$ and $(Co2)O_4$, which are connected by corners and characterized by different bond lengths. Such a feature was interpreted as favoring actual ordering of the cobalt cations in different oxidation states [4]. On the other hand, the conductivity of $YBaCo_4O_7$ ceramics seems to be predominantly p-type electronic and it is essentially $p(O_2)$-independent. The mentioned results have been achieved in polycrystalline $YBaCo_4O_7$ samples. Nevertheless, no information on the properties of this compound in form of thin film is available in literature yet. Therefore, the aim of the present work is to study the structural, transport and magnetic properties of $YBaCo_4O_7$ thin films. The films were fabricated using a dc sputtering system working at high oxygen pressures. The films were characterized after their structural, morphological, magnetic and electrical properties. X-ray diffraction analysis showed a textured growth on the sapphire substrates. Despite the high growth temperature (800°C) no indication of interface reaction (formation of $BaAlO_4$ or Y_2O_3) was detected.

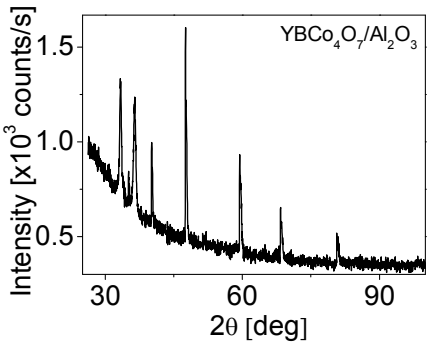

Figure 1: XRD pattern of an ~ 200 nm thin $YBaCo_4O_7$ film deposited on an Al_2O_3 substrate by high-oxygen pressure dc sputtering.

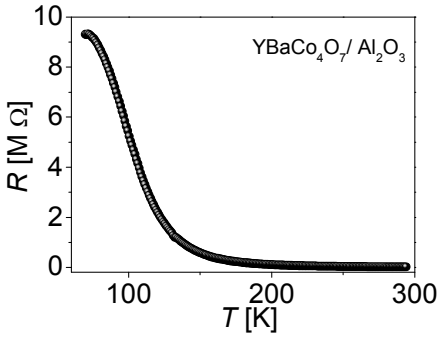

Figure 2: Temperature dependence of the resistance of an $YBaCo_4O_7$ film on Al_2O_3.

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