

Laboratorio de Materiales
Cerámicos y Vitreos,
Departamento de Física,
Universidad Nacional de
Colombia, Sede Medellín, A.A.
508, Medellín, Colombia.
Institución Universitaria
Pascual Bravo, Adscrita a la
Alcaldía de Medellín, A.A. 6564,
Medellín, Colombia.

MORPHOLOGICAL PROPERTIES OF NEW MIXED-VALENCE COBALT OXIDE $\text{YBaCo}_4\text{O}_{7+\delta}$

J.L. Izquierdo^{1,2*}

RESUMEN

Muestras policristalinas de YBaCo_4O_7 fueron obtenidas por el método estándar de reacción en estado sólido y sus propiedades morfológicas fueron cuidadosamente estudiadas. La composición química del compuesto fue obtenida usando espectroscopía de dispersión de rayos X. Los resultados indican que las muestras tienen una composición química cercana a la molar. A su vez, el análisis morfológico por medio de microscopía electrónica de barrido (SEM) indica que las muestras son policristalinas con tamaños de grano de 5 μm .

PALABRAS CLAVES:

Método de localización, Algoritmo Dist-Bug, robot móvil, incertidumbre en la medición, estimación de posición, integración de sensores.

ABSTRACT

Polycrystalline YBaCo_4O_7 samples were obtained by solid state reaction standard method and their morphological properties carefully studied. The EDS spectrum of an YBaCo_4O_7 polycrystalline sample. The analysis of the chemical composition of the YBaCo_4O_7 samples showed that their cationic contents were very close to the nominal ones. The obtained single crystals were hexagonal prisms of sizes up to 5 μm .

KEYWORDS:

Cobaltite, morphological properties, mixed valence.

* Corresponding author: jlizquierdon@unal.edu.co, jorge.izquierdo@pascualbravo.edu.co

1. INTRODUCTION

Recently, cobalt-containing oxide phases have attracted a considerable attention due to their valuable properties, including a high level of oxygen ionic and electronic conductivity [1-3], high catalytic and electrocatalytic activity [3], magnetic ordering [4,5] and superconductivity phenomenon [6]. Thus, studies on new cobaltite-based materials with improved functional characteristics are a very important issue. In recent years, a new class of complex oxides with a common chemical formula $\text{LnBaCo}_4\text{O}_7$ (Ln = lanthanoid or Y) were synthesized [7,8]. The crystal structure of these compounds, firstly reported for $\text{HoBaCo}_4\text{O}_7$ [7], was found similar to hexagonal $\text{Ba}_2\text{Er}_2\text{Zn}_8\text{O}_{13}$ [9]. This lattice comprises layers formed by two different types of cobalt-oxygen tetrahedra, $(\text{Co1})\text{O}_4$ and $(\text{Co2})\text{O}_4$, 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 [7]. The long-range charge ordering between Co^{2+} and Co^{3+} ions, below 210–220 K, and its influence on physical properties were reported earlier for another family of layered cobaltites, $\text{LnBaCo}_2\text{O}_5$ (Ln = Y, Tb, Dy, Ho) [10,11].

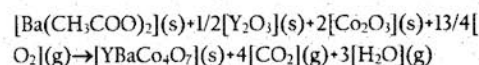
In this work, the morphological properties of new mixed-valence cobalt oxide YBaCo_4O_7 is reported.

2. EXPERIMENT

Powders of YBaCo_4O_7 (YBCoO) were obtained from stoichiometric mixtures of Y_2O_3 , $\text{Ba}(\text{CH}_3\text{COO})_2$ and Co_2O_3 reactants. After mixing the constituents thoroughly in an agate mortar, the resulting powder was slowly heated in air ($\approx 5^\circ\text{C}/\text{min}$) up to 1200°C and calcined for 48 h. After this process was accomplished, the sample was cooled slowly inside the furnace to ambient temperature. No reaction occurred between Co and the Pt crucible as it was corroborated by X-ray diffraction (XRD). The black single phase YBCoO powder was grounded and then pressed into pellets (≈ 3 cm in diameter and thickness ≈ 3 mm) which were finally sintered at 1300°C for 11h in air.

3. RESULTS AND DISCUSSION

The analysis was carried out on an unreacted starting mixture of reactants in stoichiometric amounts to resemble the synthesis conditions. The total reaction may be written as follow:



The EDS spectrum of an $\text{YBaCo}_4\text{O}_{7.6}$ polycrystalline sample after reacting the powder at 1200°C in air for 48 h using a Pt crucible followed by slow cooling to room temperature is presented in Fig. 1 (a). The analysis of the chemical composition of the $\text{YBaCo}_4\text{O}_{7.6}$ samples showed that their cationic contents were very close to the nominal ones. In addition, no traces of Pt, (confirming the absence of noticeable reaction between the sample and the Pt crucible) or other impurities as Fe or Ca were detected in

any of examined samples. Figure 1 (b) shows the corresponding SEM image of this sample. The

obtained single crystals were hexagonal prisms of sizes up to 5 μm .

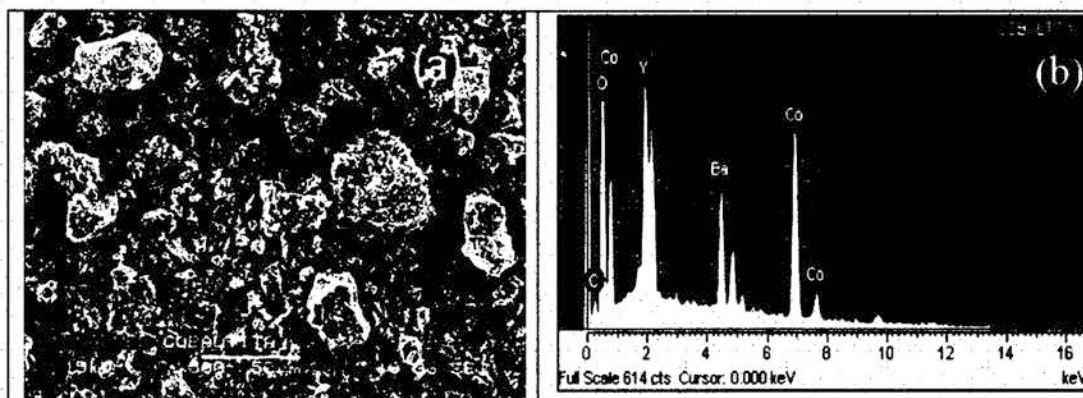


Figure 1. SEM image (a) and EDX analysis (b) of a polycrystalline sample of $\text{YBaCo}_4\text{O}_{7.6}$.

4. CONCLUSIONS

Polycrystalline samples of the new cobaltite $\text{YBaCo}_4\text{O}_{7.6}$ were obtained through standard solid state reaction and their morphological properties carefully studied. The analysis of the chemical composition of the $\text{YBaCo}_4\text{O}_{7.6}$ samples showed that their cationic contents were very close to the nominal ones. To summarize, we have investigated the morphological properties of $\text{YBaCo}_4\text{O}_{7.6}$ in detail.

5. REFERENCES

- [1] H.J.M. Bouwmeester, A.J. Burgraaf, in: A.J. Burgraaf, L. Cot (Eds.), *Fundamentals of Inorganic Membrane Science and Technology*, Elsevier, Amsterdam, 1996, p. 435.
- [2] T.J. Mazanec, *Solid State Ionics* 70/71 (1994) 11.
- [3] V.V. Kharton, A.A. Yaremchenko, E.N. Naumovich, *J. Solid State Electrochem.* 3 (1999) 303.
- [4] M.A. Senaris-Rodrigues, J.B. Goodenough, *J. Solid State Chem.* 118 (1995) 323.
- [5] I.O. Troyanchuk, N.V. Kasper, D.D. Khalyavin, A.N. Chobot, H. Szymczak, *J. Phys.-Condens. Matter* 10 (1998) 6381.
- [6] K. Takada, H. Sakurai, E. Takayama-Muromachi, F. Izumi, R.A. Dilanian, T. Sasaki, *Nature* 422 (2003) 53.
- [7] D.V. Sheptyakov, A. Podlesnyak, S.N. Barilo, S.V. Shiryayev, D.D. Khalyavin, D.Yu. Chernyshov, N.I. Leonyuk, *PSI Sci. Rep.* 3 (2001) 64.
- [8] M. Valldor, M. Andersson, *Solid State Sci.* 4 (2002) 923.
- [9] Hk. Mueller-Buschbaum, C. Rabbow, Z. Naturforsch. B 51 (1996) 343.