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# A New Series of Layered Pure Perovskites $(ACuO_{2.5})_2(ATiO_3)_m$ †

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A new homologous series of layered "pure" perovskites $(ACuO_{2.5})_2(ATiO_3)_m$ ($m = 2 \sim 4$) was found. The distance between $CuO_2$ planes can be changed by simply changing the number of $TiO_6$ blocking layers. Among them, $LaYCaBa_2Cu_2Ti_3O_{14}$ is a potential new superconductor.

## 1. INTRODUCTION

Copper-oxygen ($CuO_2$) sheets, adequate hole/electron-doping levels and appropriate Cu-O distances have proven to be necessary conditions for high-$T_c$ superconductivity. Over the last several years, our interests have been in the structural/electrical properties of the quadruple perovskites $Ln_2Ba_2Cu_2M_2O_{11}$ (M = Sn, Ti, $Ln_2 = La_2 - Tb_2$, LaY, NdDy), which have $CuO_2$ sheets separated by double $MO_6$ octahedra and can be carrier-doped by substitutions for the cations in the blocking layer [1]. Although the band structure and several features of the internal chemistry, including the amount of holes, are similar to known superconductors, the long in-plane Cu-O distances (>1.94Å) appear to inhibit superconductivity. Recently, we have discovered the $m$ = 3 and 4 members of the layered "pure" perovskites, $(ACuO_{2.5})_2(ATiO_3)_m$ [2, 3, 4]. Among them, $LaYCaBa_2Cu_2Ti_3O_{14}$ has every property in order to show superconductivity.

## 2. EXPERIMENTAL SECTION

All samples were synthesized by usual solid state reactions [4]. Powder XRD, TGA, magnetic susceptibility, HR-TEM and in-situ electrical conductivity/thermopower measurements were carried out as described before [1].

## 3. RESULTS AND DISCUSSION

The newly found perovskites , $Ln_2CaBa_2Cu_2Ti_3O_{14}$ and $Ln_2Ca_2Ba_2Cu_2Ti_4O_{17}$ form with a range of lanthanide ions, $Ln_2 = La_2 - Dy_2$, LaY - DyY and $Ln_2 = Pr_2 - Dy_2$, respectively. Along with the quadruple perovskites, $Ln_2Ba_2Cu_2Ti_2O_{11}$ ($Ln_2 = La_2 - Tb_2$, LaY, NdDy), they make a new family which has the generalized formula $(ACuO_{2.5})_2(ATiO_3)_m$, where $m$ = 2 - 4.

In contrast to the many homologous series which have been reported for the intergrowth perovskites, this is the first example of a layered-cuprate "pure"-perovskite family. Whereas $Ln_2Ba_2Cu_2Ti_2O_{11}$ ($m$ = 2) adopts a quadruple perovskite structure, $Ln_2CaBa_2Cu_2Ti_3O_{14}$ ($m$ = 3) and $Ln_2Ca_2Ba_2Cu_2Ti_4O_{17}$ ($m$ = 4) adopt a pentuple and sextuple $c$-axis-aligned perovskite structure, respectively [4]. In these structures, two, three or four sheets of $TiO_6$ octahedra comprise the blocking

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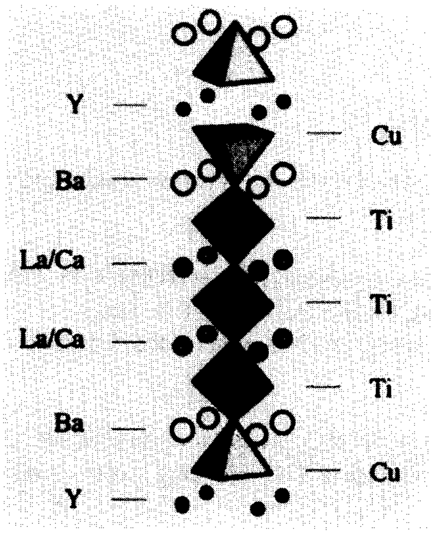


Figure 1. Suggested structure of $LaYCaBa_2Cu_2$-$Ti_3O_{14}$.

layer and separate double planes of $CuO_5$ pyramids. Thus the inter-$CuO_2$ plane distance can be varied by the number ($m = 2 \sim 4$) of $TiO_6$ sheets in the blocking layer.

The general formula can also be written as $Ln_2Ba_2Cu_2Ti_2O_{11}(CaTiO_3)_n$ where $n = 0 - 2$, showing that the pentuple and sextuple perovskites are related by the addition of one or two $CaTiO_3$ units, respectively, to the quadruple perovskite. The addition of the smaller $CaTiO_3$ unit leads to Cu-O distances in the $m = 3$ and 4 phases which are substantially shorter than that in the quadruple perovskite (1.925Å in $Tb_2Ca_2Ba_2Cu_2Ti_4O_{17}$).

Substituting Y for Ln is also an effective way to shorten the in-plane Cu-O bond length. It also helps ordering so that $LaYCaBa_2Cu_2Ti_3O_{14}$ forms a tetragonal quintuple perovskite with the lattice parameters, $a$ = 3.8675Å and c = 19.337Å (Figure 1, 2(a)), although its mother compound $La_2CaBa_2Cu_2Ti_3O_{14}$ has a cubic structure with $a$ = 3.9267Å.

Figure 2(b) shows a TEM image of the oxygen high-pressured (HIP treated) $Eu_2CaBa_2Cu_2Ti_3O_{14}$, which has a quintuple structure under ambient conditions [3]. Obviously, the layered structure is destroyed after treatment. Oxygen insertion between the $CuO_2$ planes is considered to be responsible. In $LaYCaBa_2Cu_2Ti_3O_{14}$, however, the small Y ions

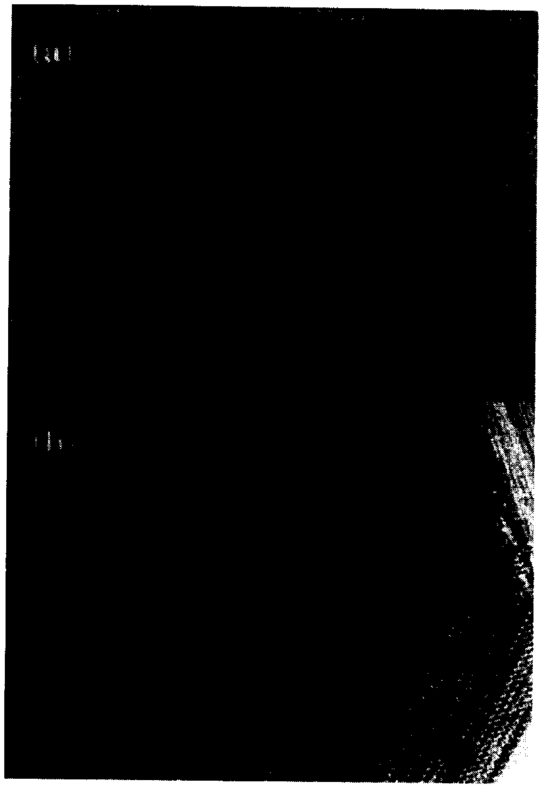

Figure 2. TEM images of (a) $LaYCaBa_2Cu_2$-$Ti_3O_{14}$ and (b) $Eu_2CaBa_2Cu_2$-$Ti_3O_{14}$ (oxygen high-pressure treated (HIP)).

narrow the spacing between the $CuO_2$ planes which can prevent oxygen diffusion.

These results and observations make $LaYCaBa_2Cu_2Ti_3O_{14}$ an attractive candidate for a new superconductor.

## 4. REFERENCES

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