

WHAT IS CLAIMED IS:

1. An improved multilayer composite article comprising 1) a substrate, 2) a first superconductive layer, 3) at least one intermediate layer comprising an insulating layer or a normal conductive layer, and 4) a second superconductive layer, wherein all of said layers at least partially overlap, the improvement comprising said first superconducting layer, said normal conductive layer, and said second superconducting layer each independently consists essentially of at least one thallium-containing oxide, and when said insulating layer is in contact with both said first and second superconducting layers, said insulating layer consists essentially of a thallium-containing oxide.

2. The article of Claim 1 wherein the intermediate layer comprises at least one insulating layer and at least one conductive layer.

3. The article of Claim 1 wherein the superconducting layers each independently are selected from the group consisting of

- I. $Tl(Ba_{1-x}M^1_x)_2(Ca_{1-y}M^2_y)_{n-1}Cu_nO_{2n+3-z}$, wherein M^1 is Sr, Ca, Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;
 x is 0 to 0.2;
 M^2 is Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;
 y is 0 to 0.4;
 n is 2, 3, or 4; and
 z is 0 to 0.5;
- II. $Tl_2(Ba_{1-x}M^1_x)_2(Ca_{1-y}M^2_y)_{n-1}Cu_nO_{2n+4-z}$ wherein M^1 is Sr, Ca, Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;
 x is 0 to 0.2;
 M^2 is Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;

y is 0 to 0.4;

n is 2, 3, or 4; and

z is 0 to 0.5; and

III. $(\text{Ti}_{1-w}\text{Pb}_w)(\text{Sr}_{1-x}\text{M}^1_x)_2(\text{Ca}_{1-y}\text{M}^2_y)_{n-1}\text{Cu}_n\text{O}_{2n+3-z}$ wherein w
5 is 0.2 to 0.8;

M^1 is Ba, Ca, Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl,
Pb, Dy, Ho, Er, Tm, or Yb;

x is 0 to 0.3;

10 M^2 is Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy,
Ho, Er, Tm, or Yb;

y is 0 to 0.6;

n is 2 or 3; and

z is 0 to 0.5.

4. The article of Claim 3 wherein the
15 intermediate layer is selected from the group consisting
of

IV. $\text{Ti}(\text{Ba}_{1-x}\text{M}^1_x)_2\text{CuO}_{5-z}$ wherein $\text{M}^1 = \text{Sr, Ca, Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;}$
20 $0 \leq x \leq 0.2; 0 \leq z \leq 0.5;$

V. $(\text{Ti}_{1-w}\text{Pb}_w)(\text{Sr}_{1-x}\text{M}^1_x)_2\text{CuO}_{5-z}$ wherein $0.2 \leq w \leq 0.8;$
 $\text{M}^1 = \text{Ba, Ca, Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;}$ $0 \leq x \leq 0.2; 0 \leq z \leq$
25 $0.5;$ and

VI. $(\text{Ti}_{1-w}\text{Pb}_w)(\text{Sr}_{1-x}\text{M}^1_x)_2(\text{Ca}_{1-y}\text{M}^2_y)\text{Cu}_2\text{O}_{7-z}$ wherein $0.2 \leq$
 $w \leq 0.8; \text{M}^1 = \text{Ba, Ca, Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;}$ $0 \leq x \leq 0.2;$
30 $\text{M}^2 = \text{Y, La, Pr, Nd, Sm, Eu, Gd, Ce, Tl, Pb, Dy, Ho, Er, Tm, or Yb;}$ $0.6 \leq y \leq 1; 0 \leq z \leq 0.5;$

$\text{Ti}_{0.5}\text{Pb}_{0.5}\text{Sr}_2\text{CuO}_{5-z}$ wherein $0 \leq z \leq 0.2;$

$(\text{Ti}_{1-w}\text{Pb}_w)\text{Sr}_2\text{CuO}_{5-z}$ wherein $0 \leq w \leq 0.5; 0 \leq z \leq$
35 $0.2;$

$\text{Ti}_{0.5}\text{Pb}_{0.5}\text{Sr}_2\text{CuO}_{5-z}$ wherein $0.25 \leq z \leq 0.5;$

$Tl_{0.5}Pb_{0.5}Sr_2(Ca_{1-y}Y_y)Cu_2O_7$ wherein $0.6 \leq y \leq 1$; $LaAlO_3$; $NdGaO_3$; and CeO_2 .

5 5. The article of Claim 4 wherein the insulating layer is in contact with only one superconducting layer and is selected from the group consisting of $LaAlO_3$, $NdGaO_3$, or CeO_2 .

10 6. The article of Claim 1 wherein the substrate is selected from the group consisting of $LaAlO_3$, $NdGaO_3$, sapphire with a CeO_2 buffer layer, MgO , or yttrium-stabilized zirconia.

15 7. The article of Claim 1 wherein the first superconducting layer is $(Tl,Pb)Sr_2Ca_{0.8}Y_{0.2}Cu_2O_7$, the intermediate layer is $(Tl,Pb)Sr_2Cu_2O_5$, the second superconducting layer is $(Tl,Pb)Sr_2Ca_{0.8}Y_{0.2}Cu_2O_7$, and the substrate is $NdGaO_3$.

20 8. The article of Claim 1 wherein the first superconducting layer is $(Tl,Pb)Sr_2Ca_{0.8}Y_{0.2}Cu_2O_7$, the intermediate layer is $(Tl,Pb)Sr_2Cu_2O_5$, the second superconducting layer is $(Tl,Pb)Sr_2Ca_{0.8}Y_{0.2}Cu_2O_7$, and the substrate is $LaAlO_3$.

 9. The article of Claim 1 in the form of a Josephson's junction.

 10. The article of Claim 1 in the form of a multi-turn pick-up coil.

25 11. An improved vapor phase process for preparing the article of Claim 1 by vapor phase deposition of successive layers by

 providing a first source of relatively volatile thallium-containing oxides,

30 providing a second source of involatile oxides,

 depositing said involatile oxides from said second source onto a substrate while concurrently depositing a sufficient amount of thallium-containing
35 oxides from said first source onto said substrate to

provide a crystalline thin film of predetermined stoichiometry,

wherein when the deposited film is a superconducting film, the improvement comprises heating
5 the superconducting film to a temperature greater than 700°C but less than the decomposition temperature of the film in the presence of O₂ or N₂O at a pressure of from about 1.33×10^4 Pa to about 10.1×10^5 Pa.

11. The process of Claim 10 wherein the
10 superconducting film is heated to a temperature of from about 700°C to about 850°C.

12. The process of Claim 10 wherein the superconducting film is heated to a temperature of from about 775°C to about 800°C.

15 13. The process of Claim 10 wherein the pressure of O₂ or N₂O is a minimum of about 6.67×10^4 Pa.

14. The process of Claim 10 wherein the pressure of O₂ or N₂O is a minimum of about 2.67×10^4 Pa.