REFERENCE


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Calculation of Material Use

\[ \text{Y}_2\text{O}_3 + 4\text{BaCO}_3 + 6\text{CuO} \rightarrow t \]

Molar Mass \( = (225.81) + 4(197.33) + 6(79.55) \)
\[ = 1492.47 \text{ g/mol} \]

To produce 50 g of YBa\(_2\)Cu\(_3\)O\(_7\),

\[
\begin{align*}
\text{Y}_2\text{O}_3 & : \quad x \text{ g} : \quad 1 \text{ mol} : \quad 225.81 \text{ g/mol} \\
t & : \quad 50 \text{ g} : \quad 1 \text{ mol} : \quad 1492.47 \text{ g/mol}
\end{align*}
\]

\[
\frac{x}{50} = \frac{1(225.81)}{1(1492.47) \text{ mol}}
\]

\[
x = (50) \times \frac{1(225.81)}{1(1492.47) \text{ mol}}
\]

\[
x = 7.55 \text{ g}
\]

\[
\text{BaCO}_3 : \quad y \text{ g} : \quad 4 \text{ mol} : \quad 197.34 \text{ g/mol}
\]

\[
t : \quad 50 \text{ g} : \quad 1 \text{ mol} : \quad 1492.47 \text{ g/mol}
\]

\[
y = \frac{4(197.34)}{1(1492.47) \text{ mol}}
\]

\[
y = (50) \times \frac{1(197.34)}{1(1492.47) \text{ mol}}
\]

\[
y = 26.45 \text{ g}
\]

\[
\text{CuO} : \quad z \text{ g} : \quad 2 \text{ mol} : \quad 79.55 \text{ g/mol}
\]

\[
t : \quad 50 \text{ g} : \quad 1 \text{ mol} : \quad 1492.47 \text{ g/mol}
\]

\[
z = \frac{2(79.55)}{1(1492.47) \text{ mol}}
\]

\[
z = (50) \times \frac{2(79.55)}{1(1492.47) \text{ mol}}
\]

\[
z = 16.0 \text{ g}
\]

Therefore, the amount of Y\(_2\)O\(_3\), BaCO\(_3\) and CuO required to produce 50 g of YBa\(_2\)Cu\(_3\)O\(_7\), are 7.55 g, 26.45 g and 16.0 g respectively.
Lattice Parameter Calculation

\[
\frac{1}{a^2} = \frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}
\]

For YBCO + 0.00 wt% PbO

At (0 1 0) plane

\[
\frac{1}{3.889^2} = \frac{1^2}{b^2}
\]

\[b = 3.889 \text{ Å}\]

At (2 2 0) plane

\[
\frac{1}{1.366^2} = \frac{2^2}{a^2} + \frac{2^2}{3.889^2}
\]

\[4 \frac{a^2}{a^2} = 0.5359 - 0.2645\]

\[a^2 = 3.6840\]

\[a = 3.8387 \text{ Å}\]

At (0 1 4) plane

\[
\frac{1}{2.3305^2} = \frac{1^2}{3.889^2} + \frac{4^2}{c^2}
\]

\[16 \frac{c^2}{c^2} = 0.1841 - 0.0661\]

\[c^2 = 8.4746\]

\[c = 11.644 \text{ Å}\]

Therefore, the lattice parameter for non-added YBCO sample is

\[a = 3.8387 \text{ Å}, b = 3.889 \text{ Å} \text{ and } c = 11.644 \text{ Å}.\]
For YBCO + 0.01 wt% PbO

At (0 0 2) plane

\[ \frac{1}{5.809^2} = \frac{2^2}{c^2} \]
\[ c = 11.618 \text{ Å} \]

At (0 1 2) plane

\[ \frac{1}{3.197^2} = \frac{1^2}{b^2} + \frac{2^2}{11.618^2} \]
\[ \frac{1}{b^2} = 0.0978 - 0.0296 \]
\[ b^2 = 14.6702 \]
\[ b = 3.8291 \text{ Å} \]

At (1 1 2) plane

\[ \frac{1}{2.4656^2} = \frac{1^2}{a^2} + \frac{1^2}{3.8291^2} + \frac{2^2}{11.618^2} \]
\[ \frac{1}{a^2} = 0.1645 - 0.0682 - 0.0296 \]
\[ a^2 = 14.9925 \]
\[ a = 3.8721 \text{ Å} \]

Therefore, the lattice parameter for non-added YBCO sample is

\[ a = 3.8721 \text{ Å}, b = 3.8291 \text{ Å} \text{ and } c = 11.618 \text{ Å}. \]
For YBCO + 0.02 wt% PbO

At (0 2 0) plane
\[
\frac{1}{1.9079^2} = \frac{2^2}{b^2} \\
b = 3.8158 \text{ Å}
\]

At (0 0 3) plane
\[
\frac{1}{3.873^2} = \frac{3^2}{c^2} \\
b = 11.619 \text{ Å}
\]

At (1 0 3) plane
\[
\frac{1}{2.7390^2} = \frac{1^2}{a^2} + \frac{3^2}{11.619^2} \\
\frac{1}{a^2} = 0.1333 - 0.0667 \\
a^2 = 15.015 \\
a = 3.8750
\]

Therefore, the lattice parameter for non-added YBCO sample is
\[a = 3.8750 \text{ Å, } b = 3.8158 \text{ Å and } c = 11.619 \text{ Å}\]
For YBCO + 0.03 wt% PbO

At (2 0 0) plane
\[
\frac{1}{1.9114^2} = \frac{2^2}{a^2} \\
a = 3.8228 \text{ Å}
\]

At (0 2 0) plane
\[
\frac{1}{1.9465^2} = \frac{2^2}{b^2} \\
b = 3.8930 \text{ Å}
\]

At (0 0 3) plane
\[
\frac{1}{3.893^2} = \frac{3^2}{c^2} \\
c = 11.679 \text{ Å}
\]

Therefore, the lattice parameter for non-added YBCO sample is
\[a = 3.8228 \text{ Å}, b = 3.8930 \text{ Å} \text{ and } c = 11.679 \text{ Å}.\]
For YBCO + 0.04 wt% PbO

At (2 0 0) plane
\[ \frac{1}{1.9082^2} = \frac{2^2}{a^2} \]
\[ a = 3.8164 \, \text{Å} \]

At (0 1 0) plane
\[ \frac{1}{3.877^2} = \frac{1^2}{b^2} \]
\[ b = 3.877 \, \text{Å} \]

At (0 0 7) plane
\[ \frac{1}{1.6654^2} = \frac{7}{c^2} \]
\[ c = 11.658 \, \text{Å} \]

Therefore, the lattice parameter for non-added YBCO sample is
\[ a = 3.8164 \, \text{Å}, b = 3.877 \, \text{Å} \text{ and } c = 11.658 \, \text{Å}. \]
Using the function of the line $y = -6696.97x + 1498.33$, the corresponding recorded temperature of the thermocouple was calculated.

The resistance was calculated using the formula;

\[ V = IR \]

\[ R = \frac{I}{V} \]

The graph of resistance against temperature was then plotted as shown in Figure 4.11 to Figure 4.14