CHAPTER 7

CONCLUSIONS AND FUTURE OUTLOOK

7.1 CONCLUSIONS

The author describes the conclusion drawn from his thesis work as follows:

(i) A new Y(12345) superconducting compound has been synthesised and characterised.
- The structure is distinctly different from the existing reported superconducting compounds and the cell parameters are $a = 5.45(3)$ Å, $b = 5.46(1)$ Å and $c = 14.62$ Å.
- Replacement of Y by rare-earth (La, Pr, Nd, Sm, Eu, Gd, Dy, Ho and Yb) yields a similar structure.
- The oxygen content is close to 15.5
- The total weight loss during TGA measurements is more in oxygen atmosphere than air and argon atmosphere with identical heating rate.
- The $T_c$ of Y(12345) is 74 K
- $T_c$ varies with rare-earth substitution in the range 50-65 K.
- La(12345) and Pr(12345) are not superconducting down to liquid helium temperature.
- The rare-earth substituted RE(12345) samples with (RE = Nd, Gd, Dy, Ho & Yb) show magnetic ordering at low temperature and, in particular, Dy(12345) reenters into paramagnetic state at very low temperature.
- The calculated effective magnetic moment $P_{eff}$ do not match the free ion moment for some of the rare-earths.
The $H_{c1}$ of the sample is 3 Gauss.

Low field hysteresis loops show anomalous behaviour which disappear at very high fields.

The thermopower of Y(12345) was negative at room temperature and shows a jump around 275 K to positive values and remains so down to liquid nitrogen temperature.

The dip at 292 K in the ac susceptibility measurements in Y(12345) and Eu(12345) is significant, but with the present data, nothing conclusively can be said about its origin.

(ii) The new 80 K Y(1234) superconducting compound was synthesised without annealing in oxygen atmosphere, and characterised subsequently.

- The powder pattern can be indexed to a tetragonal structure with the same lattice dimension as that of Tl(1234).
- The oxygen content of the sample is close to 11.
- The total weight loss in TGA runs is less in oxygen atmosphere than in air or in argon atmosphere with identical heating rates.
- The Gd(1234) also show the same $T_c$ and structure of Y(1234).
- The oxygen annealing is ineffective in altering either the cell parameters or the superconducting transition temperature.

(iii) Both Nb-Ti and Nb-Zr show significantly large values of the slope $dT_c/dP$.

- High pressure EDXRD on Nb-Ti does not show any structural change up to 60 kbar.
- The available experimental information is not enough to suggest the underlying mechanism for $T_c$ dependence on pressure.
The sample of GdBCO, HoBCO and DyBCO do not show any structural transition up to 60 kbar from the high pressure X-ray diffraction and the high pressure resistivity studies show a smooth metallic behaviour up to 80 kbar at room temperature.

All the Pr substituted YBCO compounds show a smooth metallic behaviour up to 80 kbar except Pr = 0.3, which show a significantly higher resistivity throughout the pressure range. The studies on other physical properties on the same composition support the above result.

The nitrogen annealed $Y_{0.9}Pr_{0.1}Ba_2Cu_3O_7-y$ shows an interesting behaviour in high pressure resistivity measurements compared with argon annealed, oxygen annealed, air annealed, air quenched and liquid nitrogen quenched samples.

A smooth metallic behaviour is observed for slow cooled Fe substituted YBCO and a possible metallisation was observed at 15 kbar for oxygen annealed samples of Fe substituted YBCO.

### 7.2 FUTURE OUTLOOK

The author envisions the following possible future scenario in the area of research covered by this thesis.

i) The reason for the dramatic variation of $T_c$ by rare-earth replacement in Y(12345) to see the magnetic interaction responsible for the interplay between magnetism and superconductivity in this system.

ii) Single crystal structural study, substitutional effects, Hall effect studies, application aspects, pressure effects on $T_c$ (susceptibility & resistivity), magnetisation studies at different fields and other physical properties of (Y,RE)12345, (Y,RE)1234 samples.
iii) Synthesis, characterisation, transport and physical properties of RE(1234) (RE= La, Pr, Nd, Sm, Eu, Dy, Ho, Er & Yb) samples and the reason for the large reduction in $T_c$ by replacing Tl by Y or rare-earth in Tl(1234).

iv) High pressure susceptibility studies on Nb-Ti and Nb-Zr alloys for different compositions in the very high pressure range.

The advent of high temperature superconductivity inspired the author to pursue his career in the field of superconductivity and high pressure studies on superconducting materials. An attempt has been made to present in this thesis the results of the author’s research efforts in the short span of five years.