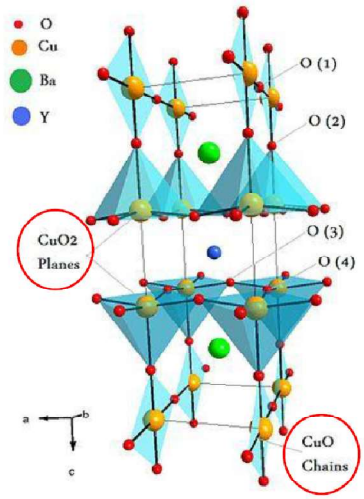
M. Sc Final (IV Semester)

Course: Paper 4104 (Section A), Inorganic Materials

Course Instructor: Professor S. Uma

Topic: High temperature superconductors (Continuation of 1-2-3 superconductor, $Y_1Ba_2Cu_3O_7$) (structure shown below)



Key features:

Square planar (Cu) units link their corners to form chains (along y) and the square pyramidal (Cu) units link up to form sheets in the xy plane.

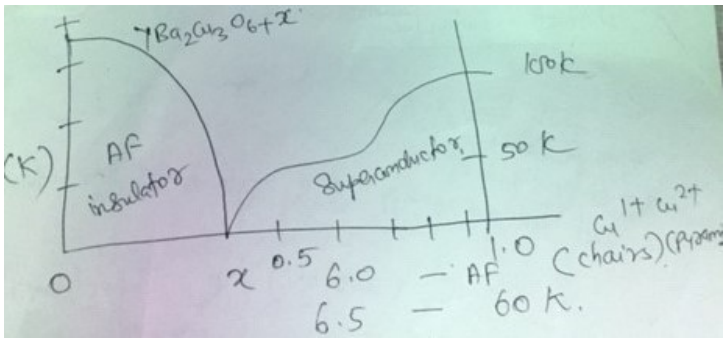
Planes of adjacent sheets are linked via square planar units to form complex triple layers.

Electron transfer can occur between Cu pyramids and Cu square planar units.

Most oxidized copper (holes) are present in the chain; Tc is primarily from square pyramidal copper units.

Internal redox or charge transfer occurs between the two units. Tc is destroyed by reducing Cu^{3+} to Cu^{1+}. (from $YBa_2Cu_3O_7$ to $YBa_2Cu_3O_6$).

Oxygen content is estimated by iodometric titration and by thermogravimetric analysis (Figure below).



The plot shows critical temperature (Tc) variation with oxygen (x) content. If you consider $YBa_2Cu_3O_{6+x}$, when x = 1 (O_7 oxide is superconducting at 90 K and Tc starts decreasing when x is decreased. 60 K for x = 6.5. When x = 0, that is $YBa_2Cu_3O_6$ is non superconducting parent which is antiferromagnetic (AFM) insulator.

APPLICATIONS OF HIGH T_c SUPERCONDUCTORS

Due to some characteristics of superconductivity i.e. the zero resistance, Meissner effect and Josephson Effect, this can be exploited for applications of these materials. There are many more application of superconductors but out of these, here we are presenting very few. New superconducting magnets could be made much smaller than a resistive magnet, because the windings could carry large currents with no energy loss.

Some applications of high temperature superconductors include; medical imaging systems, superconducting quantum interference devices (SQUIDS), analog signal processing devices, infrared sensors, magnetic shielding devices, and microwave devices, power transmission, superconducting magnets in generators, energy storage devices, particle accelerators, levitated vehicle transportation, rotating machinery, and magnetic separators will become more practical.

The ability of superconductors to conduct electricity with zero resistance can be exploited in the use of electrical transmission lines. The field of electronics holds great promise for practical applications of superconductors. The use of new superconductive films may result in more densely packed chips which transmit information more rapidly by several orders of magnitude. By using superconducting magnets, the prototype levitated trains have been constructed in Japan.