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Magnetic studies with the sample obtained from the polymeric precursor technique.

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From polymeric precursor technique, a material has been achieved which from XRD, SEM & EDS indicates presence of the superconducting material $Y_1Ba_2Cu_{2.84}O_{6.58}$, barium oxide and little sodium compound. Moment vs. temperature study and moment vs. field studies at 300K, 77K and 5K have been carried out in this present investigation. M-T plot shows ferromagnetic like behavior at very low temperature but at higher temperature region, ZFC plot is almost parallel with the temperature axis which is in favour of diamagnetism. M-H plots at 77K and 300K indicate a change of the magnetic nature of the substance at 77K from that at 300K, in the presence of a field. M-H plot at 5K is surprising from the point of view of existence of cooper pair because wide fluctuation in moment values is evident in some portions of the plot.

Keyword: Polymeric precursor, yttrium barium copper oxide, superconductivity, cooper pair, magnetic behavior.

1. Introduction

Yttrium barium copper oxide can be prepared by polymeric precursor technique [1, 5]. It has been found that sodium polyacrylate can be used as polymeric part to prepare yttrium barium copper oxide by polymeric precursor technique [5]. But material obtained in this process contain impurities like sodium oxide. So material obtained in this process is washed with distilled water and then dried to get a material which has been studied by XRD, SEM and EDS and reported in the Journal of the Indian Chemical Society [6]. These studies indicate, this more purified material contains $Y_1Ba_2Cu_{2.84}O_{6.58}$, barium oxide and very little sodium compound. $Y_1Ba_2Cu_{2.84}O_{6.58}$ is a superconducting material. So magnetic studies have been carried out in this present investigation with this more purified material to understand its magnetic behavior in better way. Moment vs. temperature study and moment vs. field studies at 300K, at 77K and at 5K have been done and reported in this present attempt. M-H plot at 5K is surprising from the point of view of existence of cooper pair and hence the work is important.

2. Materials and Methods

2.1 Materials

Yttrium barium copper oxide can be prepared by polymeric precursor technique by mixing an aqueous solution of sodium ployacrylate, Y $(NO_3)_3$ solution, Ba $(NO_3)_2$ solution, Cu $(NO_3)_2$ solution and 60% NaOH solution and the precipitate obtained is dried in an oven. To remove the polymeric part, the material is heated to 1000 ^{0}C for 1 hour in the presence of air to get $Y_1Ba_2Cu_4O_8$ [5]. Mass obtained is washed with distilled water for several times until the washing does not give a heavy white precipitate with a potassium pyroantimonate solution and then dried. When this material is studied by XRD, SEM and EDS, it has been found that it contains $Y_1Ba_2Cu_{2.84}O_{6.58}$ along with barium oxide impurity and has been already reported [6].

The Bulk EDS study shows the presence of the following atoms in the sample [6].

Atom	Wt%
O	25.29 ± 2.81
Na	2.65 ± 1.57
Cu	22.64 ± 2.52
Y	22.64 ± 2.67
Ba	26.79 ± 2.44

In this present investigation, magnetic studies have been carried out by M-T plot and M-H plots. Although $Y_1Ba_2Cu_{2.84}O_{6.58}$ is a superconducting material, but surprisingly the M-T plot at very low temperature shows ferromagnetic like behavior.

2.2 Magnetic Measurements

MPMS SQUID VSM (Magnetic property Measurement System uses Superconducting Quantum Interference Device and Vibrating Sample Magnetometer) has been used to study the magnetic behavior of the sample. 3.67 mg sample is used for magnetic measurements. For ZFC curve, sample is cooled at zero field from 380K to 5K. A field (200 oersted) is imposed for measurement. For ZFC curve, temperature is increased from 5K to 380K and for FC curve temperature is decreased from 380K to 5K in presence of a field.

In moment vs. field study, maximum field used was 5 Tesla and set temperatures were 300K, 77K and 5K. (1 Tesla => 10^4 Oersted)

3. Results and Discussion

3.1 M-T plots

Moment vs. temperature plots are shown in fig.1. FC curve and ZFC curve at very low temperature indicate ferromagnetic nature which is surprising from the point of view of superconductivity. Formation of cooper pair generally makes the superconducting material diamagnetic. Although ZFC plot at comparatively higher temperature region is almost parallel to the temperature axis. This may be in favour of superconductivity.

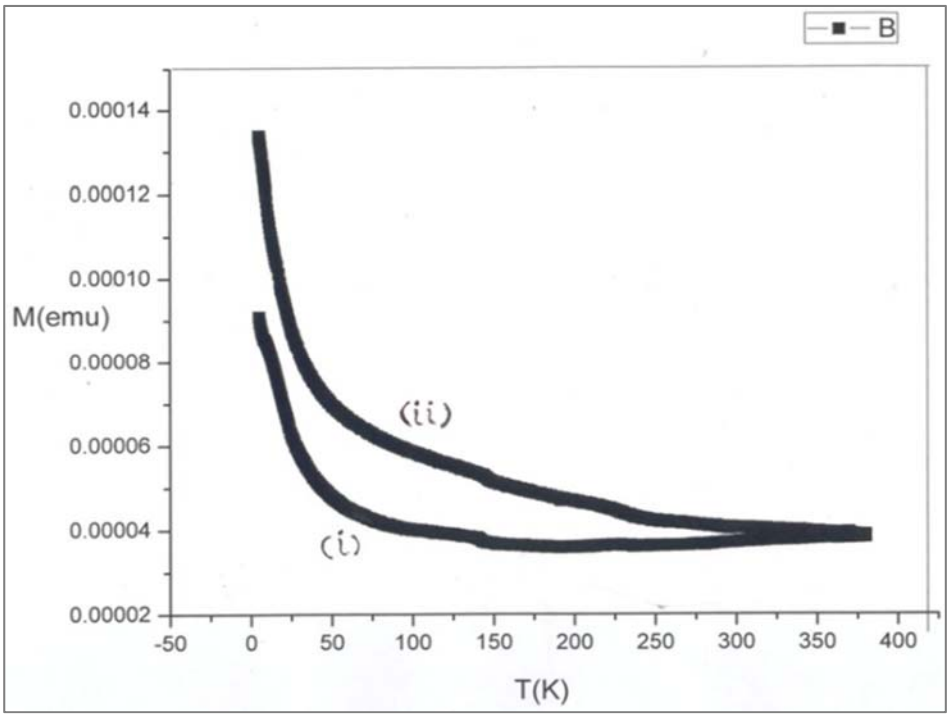

Fig 1: Moment vs. temperature plots: (i) curve for zero field cooling (ZFC) and (ii) curve for field cooling (FC).

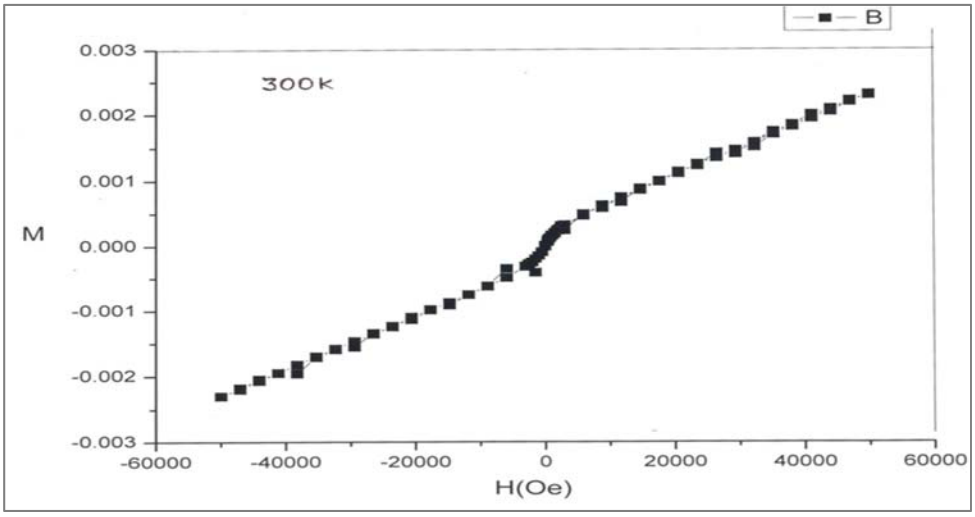

Fig 2: Moment vs. field plot at set temperature 300K.

3.2 M-H plots

Moment vs. field plots at set temperatures 300K, 77K and 5K are shown in figs. 2-4 respectively. Moment vs. field plot near about at zero field at set temperature 77K is somewhat different from that at set temperature 300K. This is probably due to differences in the magnetic nature of the substance at 77K in the presence of a field. Moment vs. field plot at set temperature 5k, shows wide fluctuation of moment values sometimes. This is really surprising from the point of view of superconductivity and existence of cooper pair at 5K in presence of a field. Cooper pair is a loosely bound pair of electrons with opposite spins and moving with the same speed in opposite directions and generally responsible for the phenomenon of superconductivity.

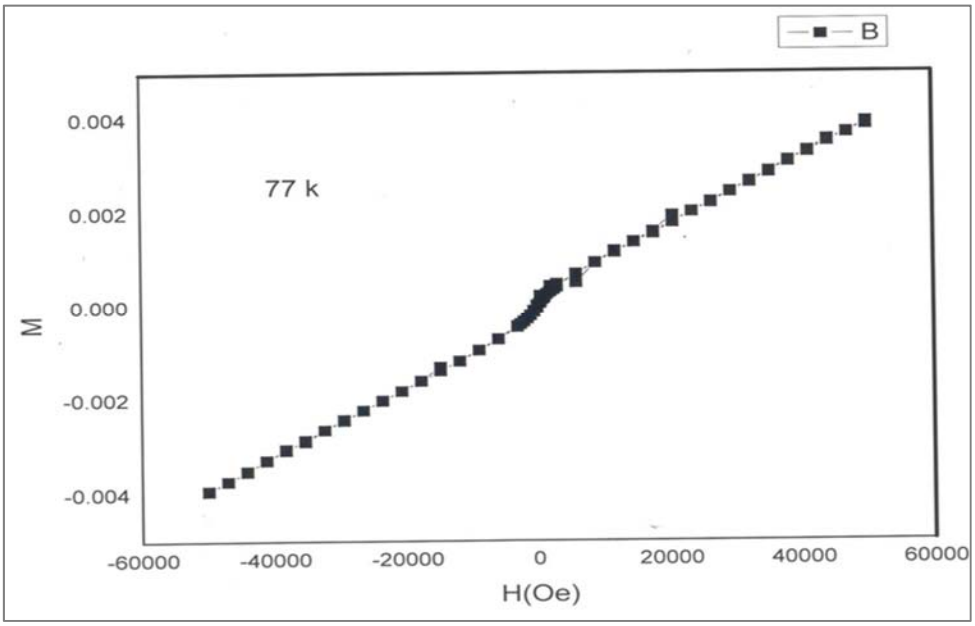

Fig 3: Moment vs. field plot at set temperature 77K.

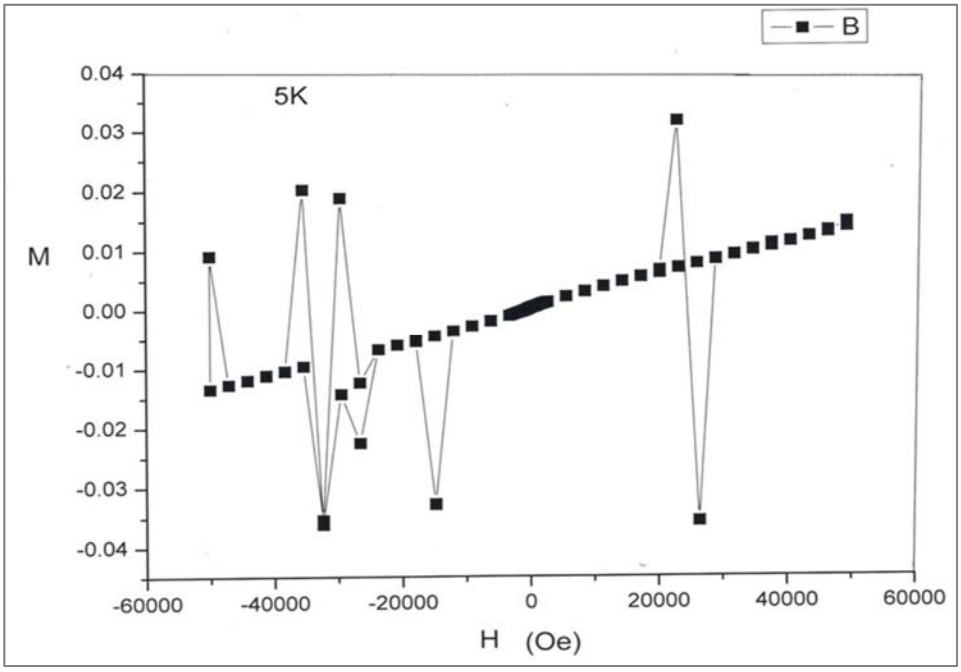

Fig 4: Moment vs. field plot at set temperature 5K.

4. Conclusion

Superconducting material due to formation of cooper pair makes the material diamagnetic. Suppression of magnetic flux (lines of force) may take place by more diamagnetic material. Since M-H plot at 5K shows wide fluctuation of moment values in some portions, this may initiate an interesting research in the future from the point of view of existence of cooper pair at 5K in presence of a field.

5. Acknowledgement

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