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MICROWAVE POWER LOSS AND XPS MEASUREMENTS ON HIGH T_c Nd-Ba-Cu-OXIDE SUPERCONDUCTING SYSTEM

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The T_c of $NdBa_2Cu_3O_x$ systaem was found to be 81 K by a microwave power loss measurements. The XPS data donot provide conclusive evidence for the presence of Cu^{3+} and the oxygen vacancies are associated with Cu and Ba ions.

1.Introduction

The Ln-Ba-Cu-O systems have been receiving considerable attention in view of the superconducting state they exhibit around 80-90K. Among these the $NdBa_2Cu_3O_x$ system has been examined by different workers using differnt methods [1-4]. Their reports though concur on the onset temperature around 90K the value of T_c reported seem to differ widely. In view of this anamoly existing in literature, it was considered worthwhile to examine the T_c of this material by another independent method namely microwave power loss measurements. The specimen of the Nd-compound used in this study was also characterised by XRD and XPS with a view to examine some of the structural characteristics of this material. The purpose of this communication is to present our XPS results on Nd-compound as well as to present microwave power loss measurement as a means of determining the T_c of oxide superconductors.

2.Experimental

The specimens studied in this investigation were prepared by grinding the appropriate amounts of Nd and Cu oxides with barium carbonate. The pelletised samples were heated at 950° C for 24 hrs with intermitant grinding and in oxygen atmosphere at 900° C for 24 hrs followed by systematic cooling to room temperature.

The microwave power loss measurements were carried out in a home-made reactangular(copper)cavity perturbation unit in X-band (8-12GHz)using a varian X-13 Klystron source, crystal detector and an 8085 microprocessor. The cavity resonance curves were recorded as a function of temperature with and without sample.

The XPS of the surface cleaned samples were recorded with an ESCALAB Mark II spectrometer using Mg K radiation with 25 eV pass energy and at an ultimate pressure of 10^{-9} torr.

3.Results and Discussion

The plot of normalised microwave power loss as a function of temperature is given in Fig.1. In order to establish the utility of this technique, the loss curves were recorded for the conventional Y-compound synthesised and included in the figure. It is seen that T_c of the Y-compound synthesised in this study had a value of 89K ,(a value of 91K was obtained by resistivity measurements) while that for Nd compound is 81K. This is in agreement with the value repored by Yang et al [3]. Since the material is diamagnetic in the superconducting state and is highly

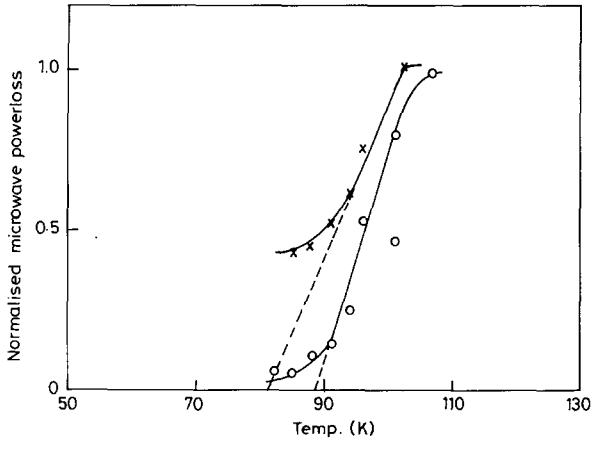

Fig.1 Normalised microwave power loss as a function of temperature —o—o— Y-compound —x—x— Nd-compound

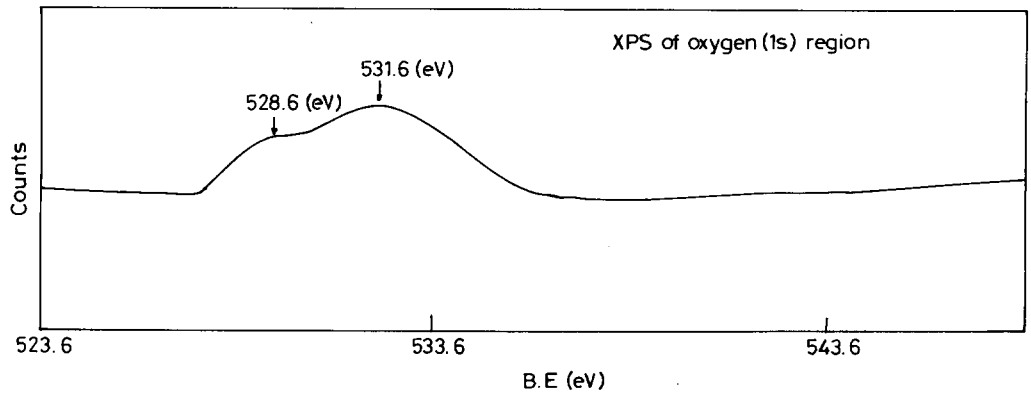

Fig.2 XPS for oxygen 1s ion of Nd compound

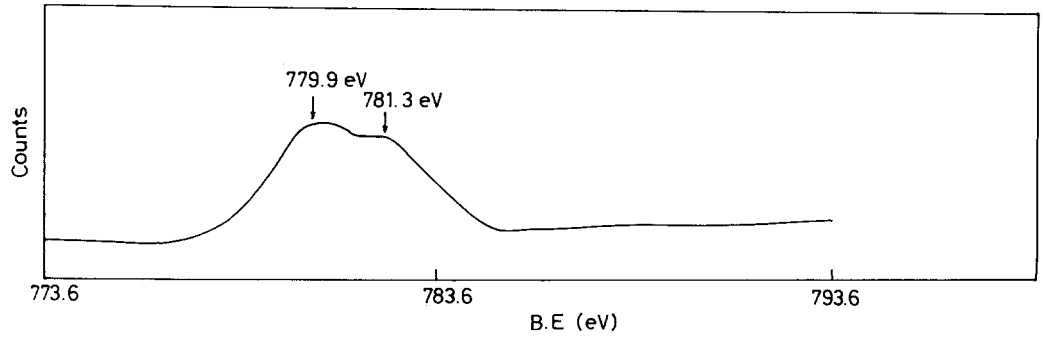

Fig.3 XPS for barium 3d region.

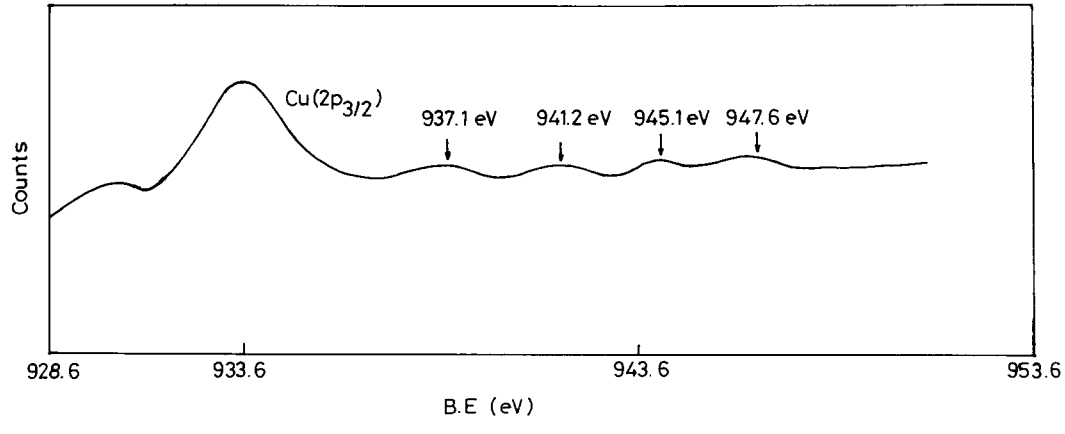

Fig.4. XPS for copper 2p region.

conducting the power loss of the sample should become almost zero because of total flux ejection. The cavity resonance curves one would obtain with the sample in this state would be similar to the response of the empty cavity. This physical basis has been exploited in the method of measurement of T_c . This method has certain advantages like (i) it does not require any electrical contacts.(ii) it appears that the residual normalised loss at the superconducting state is proportional to the inhomogeneity (and thus enabling its estimation) in the superconducting state.(iii) the magnetic loss component measured in this study ensures better thermal contact and hence can be considered to be better than the dielectric loss measurements.

The XPS spectrum of the oxygen 1s region (Fig.2) shows two different species which could be identified to be due to transition metal oxide (B.E.528.6 eV) and main group oxide (B.E.531.6 eV)[5,6]. The relative intensities of these two peaks agree with the expected value of 2. The barium 3d spectrum shown in Fig.3 indicates the presence of two inequivalent barium ions in the compound with the binding energy values of 779.9 and 781.3 eV[5]. However the copper 2p region shows a single peak with the binding energy value of 933.6 eV, slightly greater than that observed for CuO(Fig.4). This though indicates that the average oxidation state of copper could be slightly greater than 2, the presence of two distinguishable types of copper ions could not be established beyond doubt in this study. The XPS of Nd 3d and XAES of Nd MNN indicate that there is distinctly only one type of Nd species in this lattice.

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