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The Radio-Frequency (RF) fluctuations induced conduction processes in High-T_c Superconductors at room T

Hargyan Singh[$], Rupesh Kumar[*], A. K. Mahur[€] and R. Swarup[*]

[$]*Department of Applied Sciences & Humanities, Accurate Institute of Management & Technology, Greater Noida, G.B. Nagar (U.P.) India*
[*]*Department of Physics, D.S. College, Aligarh-202001 (U.P.) India*
[€]*Department of Applied Sciences & Humanities, V I T M, Aligarh-202001(U.P.) India*

ABSTRACT

The electrical conduction processes in high-T_c superconductor (HTS) pure as well as praseodymium (Pr)-doped YBCO had been observed under MRF excitations at room temperature. The high-T_c superconductor $Y_{1-x}Pr_xBa_2Cu_3O_7$ for x = 0.0 and x = 0.1 were synthesized using conventional solid state reaction method. They were employed to study the I-V characteristics of these samples under MRF-excitations. The I-V characteristics of these samples are found to be linear in nature. The Hall potentials (V_H) have also been recorded and employed to compute the various physical parameters. The doping process seems to suppress the Hall potentials and influencing all these physical parameters.

Keywords: Electrical conduction, MRF excitation, High-T_c superconductor, Hall Potential.

INTRODUCTION

An explanation to the current-voltage (I-V) characteristics of any particular material e.g. HTS is very difficult due to the many simultaneous processes that can induce the appearance of an electric field. Different models to study this dissipative behaviour have been used: thermally assisted flux flow [1], flux creep [2] and Bose glass [3] that predicted very similar behaviour, taking into account the pinning and one collective effective effect on vortex lines. It is observed that the I-V curves of channeled and pristine bridges are the linear characteristics at high temperatures close to T_c while the nonlinear, low-temperature behaviour can be well fitted by power law. It is observed that the magnitude of Hall coeffieicnt [4] varies with doping in the study of single $Y_{1-x}Pr_xBa_2Cu_3O_7$ crystals ($0\leq x \leq 1$), its temperature dependence is essentially the same for all superconducting samples. In the present attempt, we have studied the MRF-stimulated conduction processes in HTS YPBCO for x = 0.0 and 0.1. The Hall potentials had been recorded at room T and the various physical parameters such as Hall Coefficient (R_H), electrical carrier density (N_H), electron concentration (n) and plasma frequency (ω_p) had been computed.

MATERIALS AND METHODS

The synthesis of pure and Pr. doped HTS YBCO were carried out following usual solid state reactions role with Y_2O_3, $BaCO_3$, CuO and Pr_6O_{11} as the starting materials. The stoichiometric powder mixture was thoroughly grounded for 1 hour subjected to calcinations in programmable furnace naberthenin (model no. C-19) for 12 hours in air at 850°C. Further calcinations come out at 875°C. 900°C and 920°C for 12 hours each with intermediate grindings. Final concealed material was made in pallet form at 5 k bar sweltered at 930°C in flowing oxygen with the schedule (930°C/24h/O_2) →(750°C/24h/O_2) → (600°C/24h/O_2) → (400°C/24h/O_2) → furnace off and cool to room T in O_2.

For Hall effect measurement, the pure as well as Pr-doped HTS YBCO samples were employed in six-probe Hall geometry using RF singling upto 7MHz at an angle ~ 45° in x-y plane, current density j_x in x- direction and magnetic field H in z-direction. Silver paste was used to make the electrical contacts on the surface of the sample. The frequency dependent Hall potentials (V_H) were recorded for both the samples at magnetic field H=6000 Gauss employed to compute the above mentioned physical parameters.

RESULTS AND DISCUSSION

The radio-frequency stimulated V-I characteristics of pure as well as 10% Pr-doped YBCO at f = (1, 2) MHz with H= 0 G and H=6000 G had been depicted in figures (1, 2, 3 and 4) respectively. It had been observed that in all the figure the I-V characteristics are found to be linear in nature. The frequency dependent Hall potential (V_H) of pure as well as 10% Pr-doped YBCO with magnetic field H=6000G at x-direction current i_x = 5 mA had been depicted in Fig.5. It had been observed that in the Fig.5, the Hall potentials increase with the rise of frequency in oscillatory fashion for both samples. The frequency dependent physical parameters of pure as well as 10% Pr-doped high Tc superconductor YBCO at H= 6000 Guass had been computed as given in table 1 and table 2, the Hall coefficient varies in oscillatory[5] manner ranging between ΔR_H = (0.17-7.47) x10^{-14} esu and ΔR_H = (0.17-5.89) x10^{-14} esu in similar frequency range for both the samples. The frequency dependent electrical carrier density N_H~10^{13} esu, electron concentration n~10^{12} esu and plasma frequency ω_p~10^{10} sec^{-1} had been observed in table1 and table 2 for both sample respectively it is evident that the order of all these parameters for both samples are in the same order but varying with frequency in magnitude.

The RF-Stimulated V-I Characteristics of HTS $YBa_2Cu_3O_7$ at room T and f = (1, 2) MHz respectively.

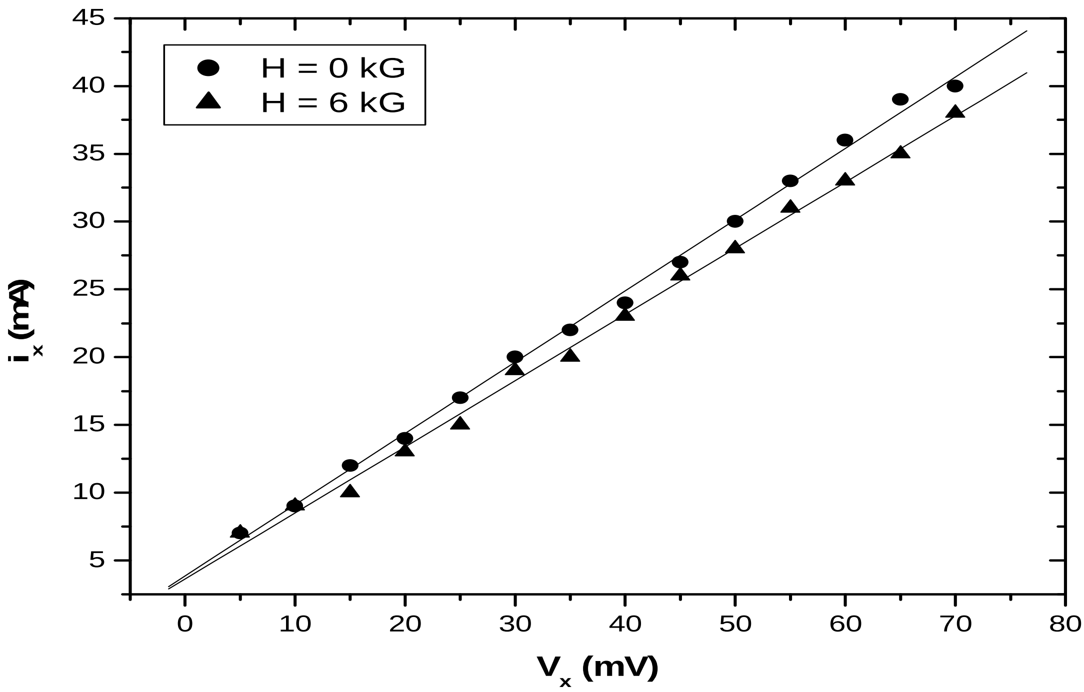

Fig. 1

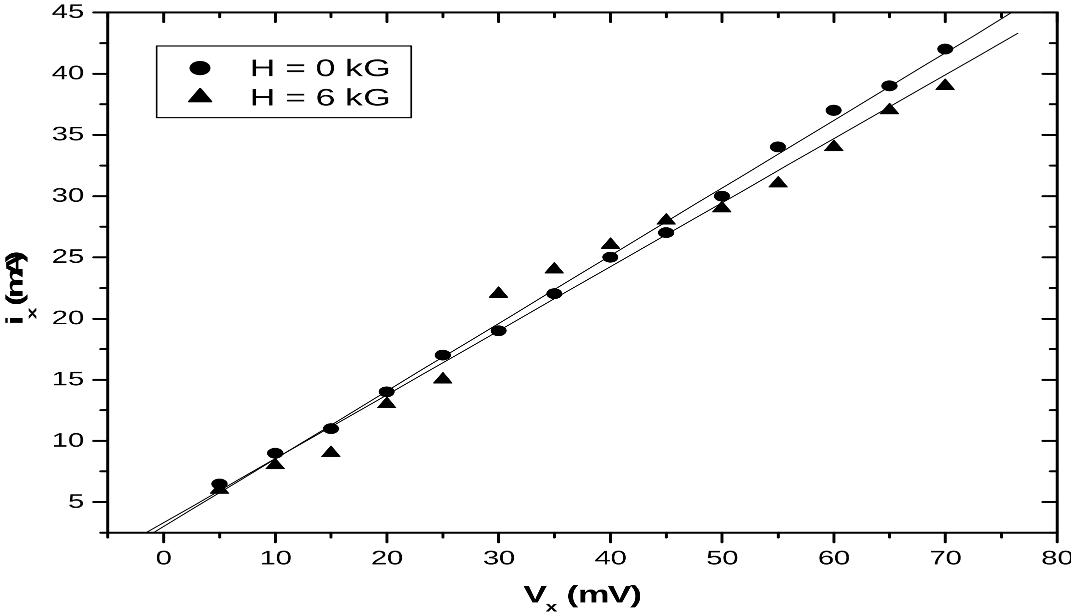

Fig. 2

The RF-Stimulated V-I Characteristics of HTS $Y_{0.9}Pr_{0.1}Ba_2Cu_3O_7$ at room T and f = (1, 2) MHz respectively

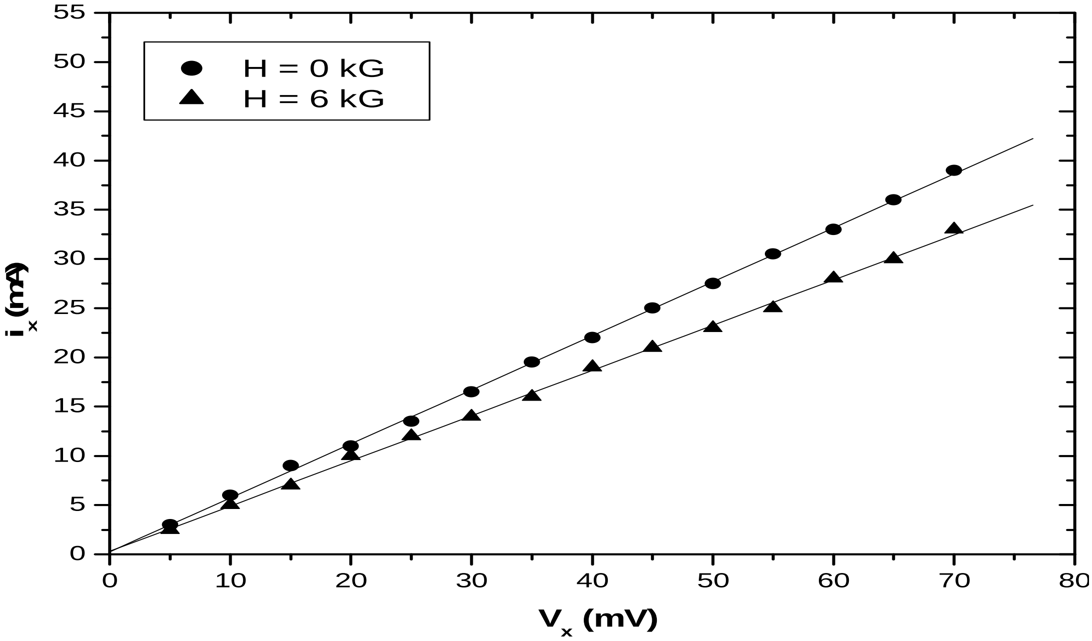

Fig.3

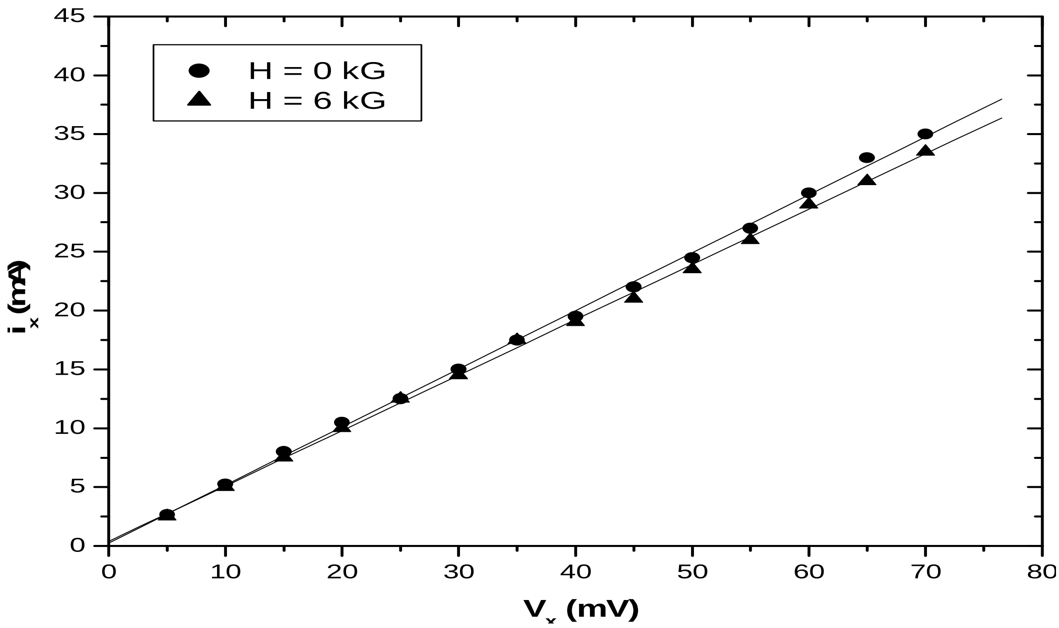

Fig. 4

The RF-stimulated Hall coefficient, electrical carrier density, electron concentration and plasma frequency of HTS $YBa_2Cu_3O_7$ and $Y_{0.9}Pr_{0.1}Ba_2Cu_3O_7$ at H = 6000 Gauss, i_x = 5mA respectively.

f (MHz)	$R_H \times 10^{-14}$	$N_H \times 10^{13}$	$n \times 10^{12}$	$\omega_p \times 10^{10}$
0	0.17	58.82	20.8	25.67
1	3.07	3.25	1.18	6.11
2	3.4	2.94	1.06	5.79
3	4.23	2.36	0.85	5.19
4	5.64	1.77	0.64	4.50
5	5.97	1.67	0.60	4.36
6	7.22	1.38	0.50	3.98
7	7.47	1.33	0.48	3.90

Table-1

f (MHz)	$R_H \times 10^{-14}$	$N_H \times 10^{13}$	$n \times 10^{12}$	$\omega_p \times 10^{10}$
0	0.17	58.82	20.45	25.45
1	2.90	3.44	1.23	6.24
2	3.25	3.07	1.10	5.90
3	3.43	2.91	1.04	5.74
4	4.13	2.42	0.87	5.25
5	4.66	2.14	0.77	4.94
6	5.36	1.86	0.67	4.60
7	5.89	1.69	0.61	4.39

Table-2

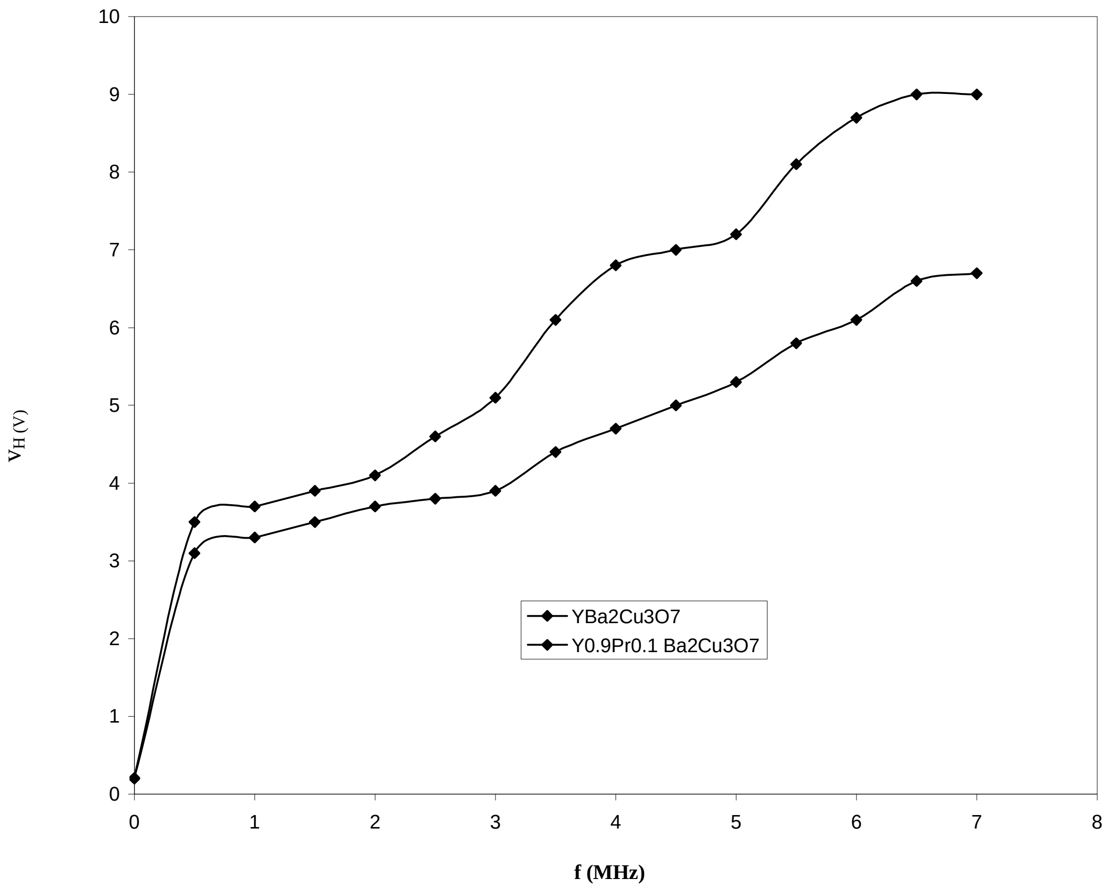

Fig. 5: The Frequency dependent Hall potentials of pure and 10% Pr-doped YBCO at H = 6000G and i_x= 5mA.

CONCLUSION

The electrical as well as magneto conductions of pure as well as 10% Pr-doped YBCO are deeply influenced by MRF perturbation at room temperature. The doping of Pr in high-T_c superconductor YBCO seems to suppress the Hall potentials in the same order.

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REFERENCES

[1] Tinkham M, *Phys. Rev. Lett*., **1988**, 61, 1658.
[2] Feigelmann M V, Geschkenbein V B, Larkin A I and Vinokur V M, *Phys. Rev. Lett*., **1989**, 63, 2303.
[3] Dekker C et al., *Phys. Rev. Lett*., **1992**, 69, 2717.
[4] Jukna A et al., *J. Appl. Phys*., **2006**, 99, 113902.
[5] Singh H, Kumar P, Mittal M, Bala S and Swarup R, *Proc. of Solid State Phys. Symp*., 26 - 31 Dec. **2006**, (Barkatulla University, Bhopal), 51, 641.