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The MRF Perturbative Conduction Processes in 10% Pr-Doped HTS Y_{123}

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The 10% Pr-doped HTS Y_{123} synthesized using conventional solid state reaction methods in compressed pellets with 4 – probe Hall geometry were employed for studying the MRF stimulated conduction processes with desired T_c shifts towards room T side in these materials.

Keywords: High Temperature Superconductors (HTS), Doping, Superconductivity.

1. INTRODUCTION AND THEORY

The ionically conducting disordered solids such as ion conducting doped crystals, poly-crystals, ion conducting glasses, amorphous semiconductors, ion conducting polymers and HTS share common features (1) disordered arrangements of the mobile ions within rigid matrix [1,2]; (2) thermally activated hopping processes of mobile ions, giving rise to a dc conduction and (3) the remarkable features of ac conductivity and its scaling behavior which are the major field of recent researches [3,4]. Almost a constant conductivity is observed at low frequency while it becomes highly frequency dependent at large frequencies in the shape of power low fashion, $\sigma'(f) \propto (f)^n$, upto phonon frequencies. In the present study, the ac conductivity and its scaling behavior in 10% Pr-doped HTS Y_{123} had been interpreted using random free energy barrier mode. The transverse ohmic potential (V_y) and magneto potentials (V_y'), Hall voltage V_H, the longitudinal i_x and the transverse i_y current component had been recorded under MRF excitations [5-9].

The ac conductivity $\sigma'(f)$ expressed by Barton, Nakajima, Nakmikawa (BNN) relation [3]

$$\sigma'(f) = \sigma_{dc} [1+(f/f_{Max})^n]$$

Where f is excitation frequency, f_{Max} is relaxation frequency and n the dimension less frequency exponent normally lying in the range 0<n<1 scaling grain size. It suggests that the grain boundaries in these materials are in the disordered form. In the limiting behaviour when n value approaches to 1 the universal dynamic response characterize the universal phenomenon [4].

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2. EXPERIMENTAL STUDY AND ANALYSIS

Air drying silver paste (paste was formed of isoamil acetate, which is in liquid form) was used for making electrical contacts on the samples. The sample temperature was monitored within an accuracy of ±0.1K using a standard 100 Ohm platinum sensor in conjunction with the keithley 224 programmable constant current source and keithley 181 nano Voltmeter [10].

The 10% Pr-doped HTS Y_{123} shows semiconducting character having dc conductivity ~ 0.0376 $(\text{Ohm m})^{-1}$ which undergo a sudden phase transition having its amplification ranging in order of ~10^6 under RF excitation. These values are highly enhanced with respect to pure HTS Y_{123}; amplification being ~ 530 at f = 5MHz & ~ 10^5 at f = 7MHz its ac conductivity σ'(f) its variation with frequency has been depicted in Figure 1 i.e. fast rise for f between 0-0.5 then slow spontaneous oscillatory rise reaching upto ~16983.69 $(\text{ohm m})^{-1}$ at f = 7 MHz.

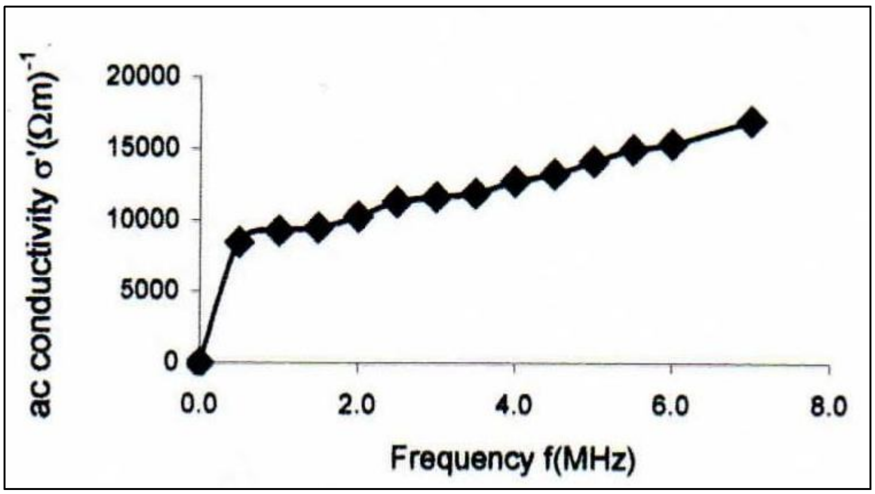

Fig. 1: The RF stimulated ac conductivity in 10% Pr-doped HTS Y_{123}.

The x terminal dc-voltage application on Hall probe of 10% Pr-doped HTS Y_{123} under magneto (H_z = 6KG) radio frequency (45° x-y plane) excitations yield the following results as shown in Figure 2,3,4 and 5.

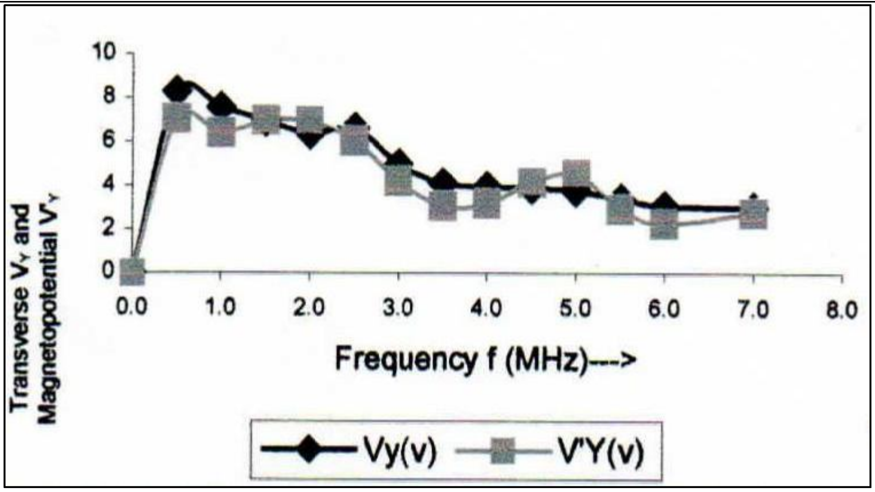

Fig. 2: The magneto splitting of transverse potential in 10% Pr-doped Y_{123}, V_x = 2V, H_z = 6KG.

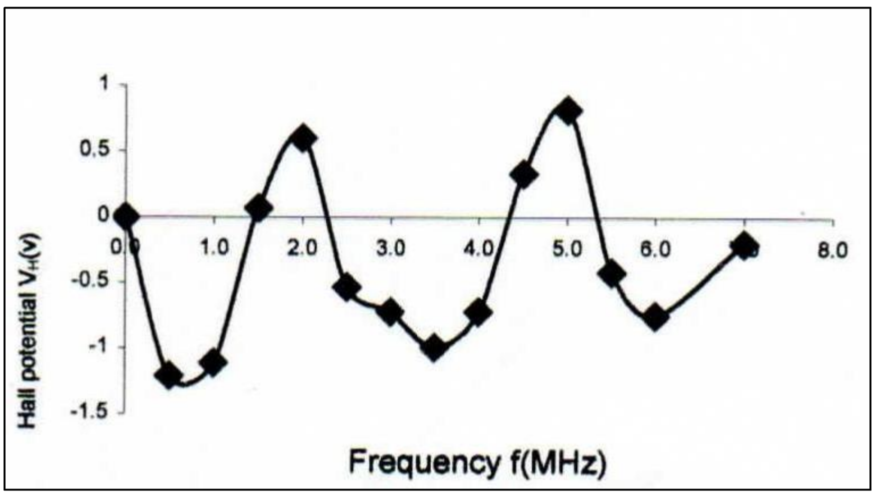

Fig. 3: The RF stimulated Hall voltage in 10% Pr-doped Y_{123}, V_x = 2V, H_z = 6KG.

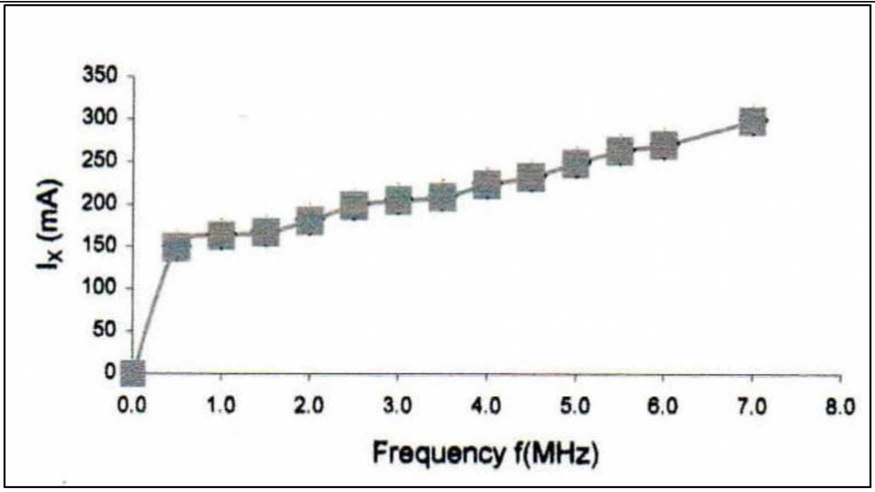

Fig. 4: The frequency dependent current component I_x in 10% Pr-doped Y_{123}, V_x = 2V, H_z = 6KG.

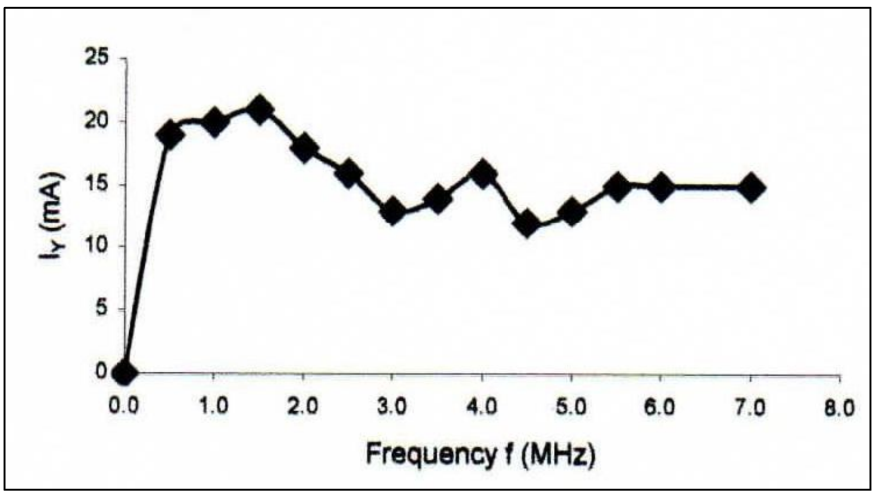

Fig. 5: The frequency dependent current component I_y in 10% Pr-doped Y_{123}, V_x = 2V, H_z = 6KG.

3. RESULTS, DISCUSSION AND CONCLUSION

The transverse potentials both ohmic and magneto recorded at room temperature under RF excitations had been shown in Figure 2. It may be noted that a sharp rise from 0-8 V for ohmic a 0-7 V for magneto transverse voltage for f between 0 and 0.5MHz revealing magneto splitting ranging upto 1 volt had been observed. Then slow transverse voltage fluctuations in decaying mode relaxing near 3 volt having magneto splitting 0.2 volt is observable. The Hall potential record had been shown in Figure 3 which have periodicity 2.8 MHz and amplitude of oscillation ranging from -1.2 volt to +0.6 volt. In 10% Pr-doped HTS Y_{123} the i_x, stepped development at first saturating value 150 mA with frequency rise 0.5 MHz from initial f = 0MHz and then a slow rise approximately linear in nature reaching upto 300 mA at f = 7MHz had been shown in Figure 4. The i_y-f characteristic curve is oscillatory as shown in Figure 5. The current amplitudes varying between (0-21) mA, maximum at f = 1.5MHz reaching a saturation value 15 mA after f = 5.5MHz. The frequency periodicity ranges from 7MHz to 6MHz at room temperature and Hz = 6KG.

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