International Journal of Computer Applications (0975 – 8887)
Volume 55– No.18, October 2012

Temperature Dependant Bundle Size in YBaCuO Thin Film

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ABSTRACT

In this article we intend to analyze the spectral density Sv(0) at frequency zero, and bundle size in a type II superconductors , This spectral noise density is determined from experimental results , In continuation one will study the variations of the bundle size according to the temperature of the applied magnetic field and the electric current crossing the sample.

Keywords

Superconductors, YBaCuO, Bundle size, Flux flow noise, spectral density, superconductivity, high critical temperature.

1. INTRODUCTION

The voltage noises generated by the viscous flow of flux and derive expressions for the power spectrum of the noise will be described. The YBaCuO film used has a width w and length l between the potential probes in a perpen-dicular magnetic field. Transport current flows in a direction perpendicular to the field and along the length of the sample.

Discrete flux entities of magnitude ϕ, which is an a priori unknown multiple of the flux quantum ϕ_0, are generated at the edge of the superconductor at random times. They subsequently flow, independently of each other, across the superconductor and it takes a time τ for them to cross the specimen The flux enti-ties, which in type-Il superconductors are bundles of vortex lines (flux bundles), are assumed to follow the same velocity time function, so that identical voltage pulses are generated. The flux is moving in a direction perpendicular to current and field, which means that guided motion and the Hall Effect are neglected.

As follows from

$$E = \frac{-1}{c}\left(\overrightarrow{\vartheta} \wedge \vec{B}\right)$$

the flow of one flux bundle gives rise to a potential difference between the probes, for

$$0 < t < \tau \quad V(t) = \frac{\phi \,.\, \vartheta(t)}{c.w}$$

where v(t) is the velocity, which may be time-dependent. The area under the voltage pulse is determined by the amount of flux that is transported and is equal to Φ/c. If N is the average flux-bundle-generation rate, the average voltage across the sample can be written,

$$V = \langle V \rangle = N.\int_0^{\tau} V(t).dt = N.\frac{\Phi}{c}$$

The mean-squared noise voltage in a frequency band between f and f + df is $\langle \delta V^2 \rangle = S(f).df$. If the generation and annihilation of the bundles is instantaneous and the velocity is constant, the resulting

voltage pulse is a rectangular one [1]:

$$V(t) = \frac{\Phi}{c.\tau} \quad \text{for} \quad 0 \le t \le \tau, \quad V(t) = 0$$

otherwise ,

$$S(f) = \frac{2.\phi.V}{c}\left(\frac{\sin(\pi.f.\tau)}{(\pi.f.\tau)}\right)^2$$

The expression for the power spectrum of the flux flow noise at f=0 all give a value

$$S(0) = \frac{2.\Phi.V}{c}$$

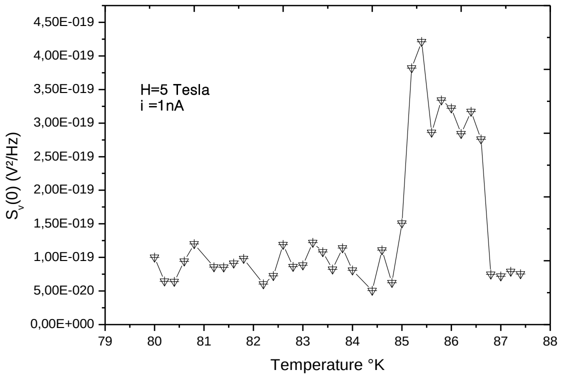


Fig. 1: The temperature dependence of Sv at f = 0 Hz

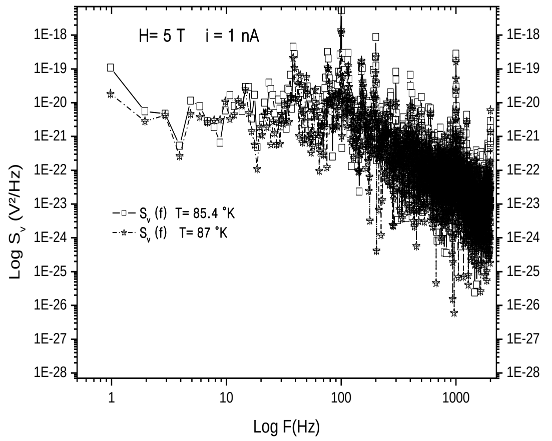


Fig 2. The frequency dependence plotted in Log-Log scale of the voltage noise spectral density Sv(f) for two values of temperature T= 85.4K and T= 87K under a magnetic field H= 5T.

2. EXPERIMENTS

The studied sample is a $YBa_2Cu_3O_7$ thin film deposited by the ablation laser method on the surface (001) of a $SrTiO_3$ substrate. the resistance vanished. In zero magnetic field, at Tc= 90K The C-axis of YBaCuO is perpendicular to the film surface. Electrodes of measurement are in gold and deposited on the surface of the sample in situ by evaporation. The film has a thickness of 400 nm, and a width 7.53 µm. The distance between electrodes of power measurement is 135 µm. Contact resistances were less than 1 Ω. Noise spectra were measured by a DC four-probe method. For experiences 1nA is used perpendicularly to the applied magnetic field direction. The noise amplitude is visualized on a programmable oscilloscope after it has been amplified by a preamplifier of gain equal to 100 and filtered in a RC filter. The signal is finally recorded then analyzed by computer

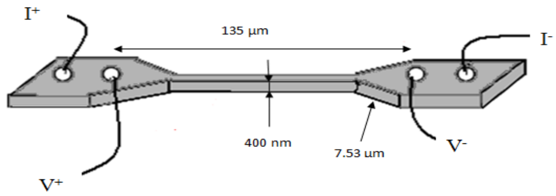


Fig. 3-a : Schematic representation of our sample $YBa_2Cu_3O_{7-\delta}$.

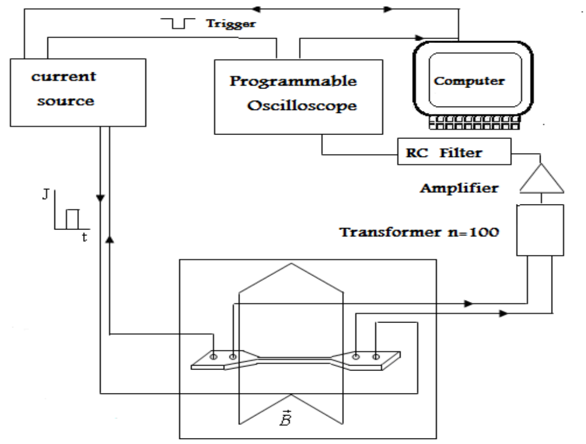


Fig. 3-b: Schematic of measurement principe.

3. RESULTS

Noise spectra were measured for various combinations of magnetic field, and temperature.

The value of Φ can be determined from the value of S(0), and the d.c. voltage V by using

$$S(0) = \frac{2.\Phi.V}{c}$$

Figure 1 shows the frequency dependence of the noise spectral density for two values of temperature T= 85.4K and T= 87K under a magnetic field H= 5T.

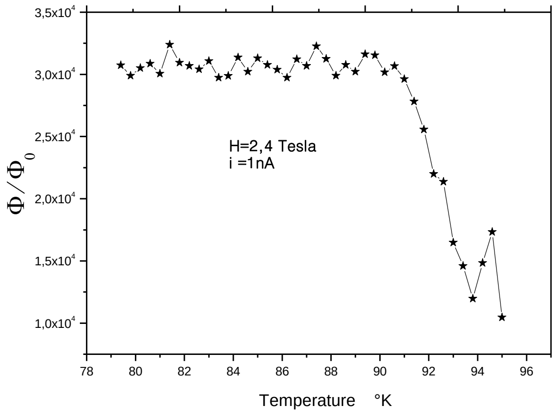
Figure 2 shows the temperature dependence of the noise spectral density at the frequency 0 Hz for a magnetic field of 5 T parallel to the (ab) planes.

Figure 4 shows the flux bundle size versus temperature for two values of magnetic field H = 5 T and H=2,4 T. i=1nA

The flux bundles become smaller when the megnetic field is increased and when the effect of pinning are diminished.

A model for the bundling of the vortex lines should take account of these results.

This bundling of vortex lines was originally proposed by Anderson [2] in his theory of flux creep. He suggested that vortex lines would not jumpover pinning barriers alone, but would move in bundles if the driving force on a single vortex line is not large enough to push it over a barrier. clustering may occur.



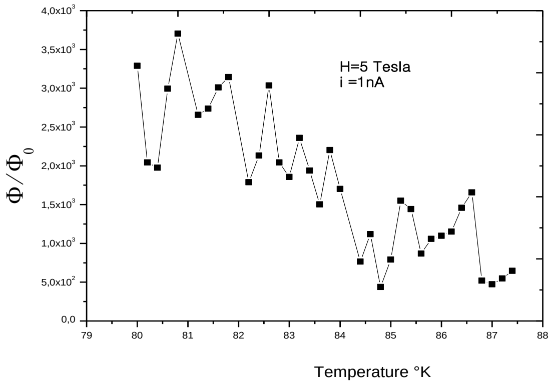


Fig 4: flux bundle size versus temperature for two values of magnetic field H = 5 T and H=2,4 T. I = 1nA.

4. CONCLUSION

The bundle size for a constant value of current density J decreases with increasing temperature, that a temperature increase causes a reduction of the pinning, and we interpret that the temperature dependences of the flux bundle size are the reasons for the noise peaks, and a rough estimation of the temperature and field dependence of the flux bundle size is presented. For higher fields, the interaction between the vortices is dominant, bundle of vortices of critical volume Vc form and become collectively pinned. The long range order of the vortices is still preserved within the bundle [3].

5. REFERENCES

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