FIRST EXPERIMENTAL RESULTS FOR HIGH Tc MAGNETRON SPUTTERING ON THE WORKING SURFACE OF RF ACCELERATING CAVITIES

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The report describes the first experimental results on High Tc magnetron sputtering on the working surface of galvanoplastic copper with use of the buffer layers (Ag, Ni, Al, AL-Cu). Copper shells of SC cavities with complicated geometry of the "TESLA-shape" type is executed by the galvanoplastic forming method /1,2/.

The SC films on the base of Y-Ba-Cu-O put by the method planar or axial magnetron sputtering / 3-7 /.

The first results of measurements of sample and cavities parameters High Tc / copper basis are discussed.

1. Introduction

The modern stage of the accelerating engineering development is characterized more and more by the wide application of the SC accelerating structures. The SC cavities on the base of copper, covered SC films are favourable in comparison with conventional technologies of the SC cavity made of the Nb ingot or sheet material / 8,9/.

As the advantages of such technology the low cost of articles, best adaptability of manufacturing one of complicated shape, good achieved results may be considered /4/.

Alongside with the conventional Nb SC cavity technology, the RF cavity technology on the base: Nb/Cu, NbTi/Cu, HTC/Cu is applied.

High Tc materials on the YBaCuO base are perspective for decisions of the high accelerating field problem. On the seminars on future prospects for high energy physics and the conferences on RF superconductivity /4-7, 9-15/ more often the question about opportunity of receiption of accelerating fields of order 400 MB /M at use the ideal SC YBaCuO film in comparison with the ideal Nb or Nb Sn cavities is discussed, where the accelerating fields 50 MB/M and 150 MB/M accordingly are possible to receive /4/.

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The RF surface resistance of YBaCuO at the 77 K is smaller than of Nb at 4.2 K from the theoretical point of view /4/.

2. The Starting Materials

The high Tc films used for SC cavities are required will the next characteristics: rigid pure, uniform, dense, stable, clean etc. Besides no oxygen desorption even though it is heated in vacuum /4/ and good mechanical strength. The high Tc film must have no defects on the grain bondaries, the good film adgesion to galvanoplastic copper shell of SC cavity at thermocycles from 4.5 K to 300 K is necessary.

We have used the starting SC YBaCuO material, made by plant "Polymetall" (State plant, Moscow) /16,17/.

The galvanoplastic copper samples and copper shells are manufactured accoding to the technology, developed at Federate Problem Laboratory /1,2/

3. The Technological Equipment

We used the following equipment for the manufacturing the SC cavities with "TESLA-shape": the galvanoplastic forming area, the axial magnetron sputtering stand and the model of the planar magnetron sputtering setup.

The possibilities of the galvanoplastic forming method and the equipment required for it was decribed in /1,2/.

The copper shell SC cavities shall be covered by high Tc film on the magnetron sputtering stand, described in /18,19/.

The necessity of manufacturing SC cavities of different shape to be used in electron and ion linear accelerators /20,21/ and also for stabilization of the high stable oscillators ("Frequancy-Time" Program) demands to develop axial and planar magnetron sputtering technologies.

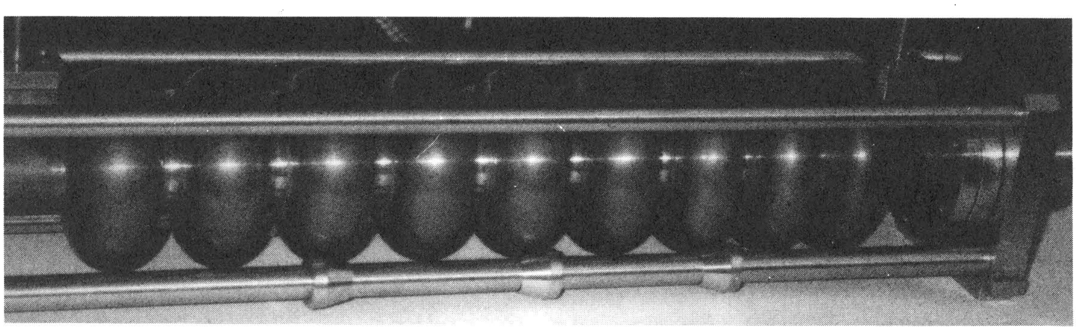

Fig.1 SC "TESLA-shape" cavity for the electron accelerator made in our lab. / 20 /

4. Stand for Axial Magnetron Sputtering

At present the stand for axial magnetron sputtering commissined.

The outward view of the stand for axial magnetron sputtering is shown at Fig. 2.

Basic stand parameters :

The sizes of working chambers	- length of 500 mm, diameter of 160 mm. ;
The utmost vacuum before covering	- 5 x10 (-7) Па;
The work gas	- argon;
Cathode material and sputtered alternating details	- dependent an material
The cathode diameter	- 8-30 mm;
Voltage at cathode	- up to 950 In;
The rotation velocity of copper shell	- 1 rot. per minute. ;
Catode cooling	- gaseous nitrogen, water.

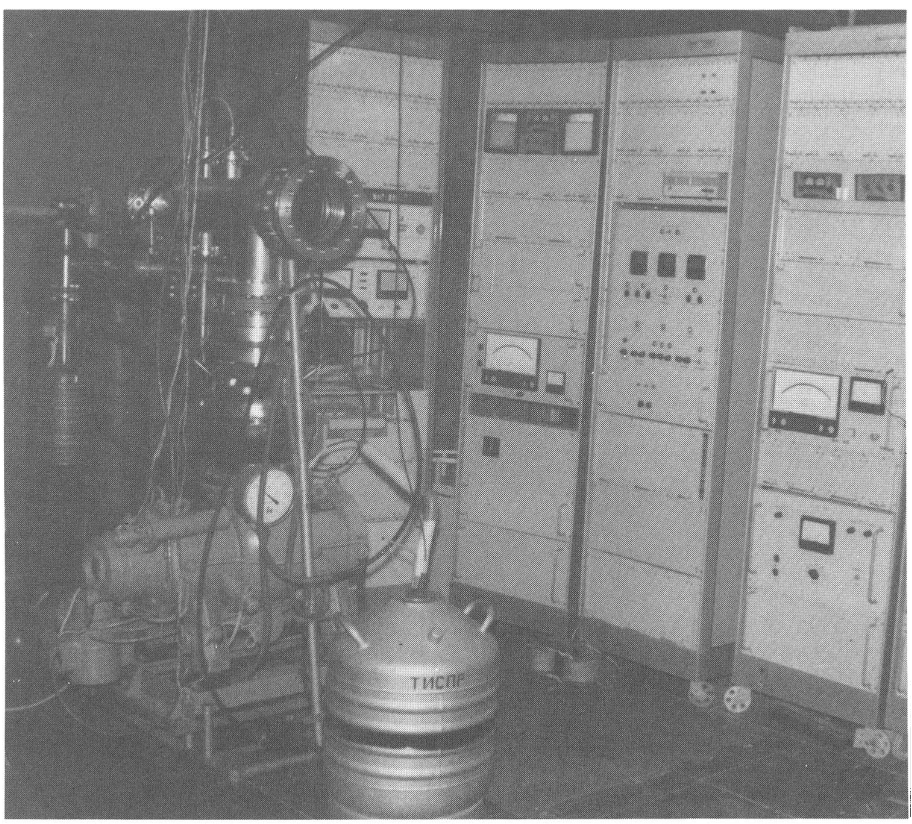

Fig. 2 The outward view of Stand for axial magnetron sputtering

The fuctional scheme of this stand, catode assembly construction and vacuum system are described in / 18,19 /.

The current characteristics of magnetron discharge were studied in details using different sputtered materials including Nb, allow H2B and YBaCuO and the regime of its sputtering was choosed.

5. The Buffer Layer Influence

To deposit the of required quality at the working of copper shell surface is necessary to solve the problem to garantee of the YBaCuO film stability with 1-2 micron thickness. The problem is to conjugate crystallografic structures of YBaCuO and copper.

Accoding to /23/, the conjugation possibility increases if lattice parameters start increasing from 3.61 to the movest lattice parameters of YBaCuO, where a=3.82 and b=3.89.

There are many recomendation of different firms on buffer layers between copper and YBaCuO. For example, Ag, Ni, Pt /4/, solid solution Al-Cu /23/,ZrO. Using theese recomendation, different buffer layers have been tested, and the best preliminary results have been got for buffer layer from solid solution of Al-Cu.

6. The Discussion of Results

The copper shells of SC cavities on which film high Tc put on, were made by galvanoplastic forming method. Accoding to the data of joint experiments with Centres of Strength of Russian Space Agency, they have heat conductivity and temperature factor of expansion, close to ingot copper without oxygen.

The experiments on covering the surface of copper shells of complicated shape with have shown the advantage of the buffer layer technology on the buffer layer basis of solid solution Al-Cu.

The film YBaCuO put on the working surface of the "TESLA-shape" copper shells with use of buffer layer Al-Cu had the best adghesion and the rough.

The uniformity of YBaCuO cover thickness on the working surface of copper shells of the cell SC cavities were investigated by means of the metallographyc edges, made of part of surface, taken from the cell equator, near to aperture or from any other part of cavity.

The thickness of film measured with the MII-4 microinterferometer or metallographic MiM-7 microscopy.

On Fig.3 the dependence of YBaCuO film thickness of the surface of copper shell of cavity on arragenment of analysed is presented.

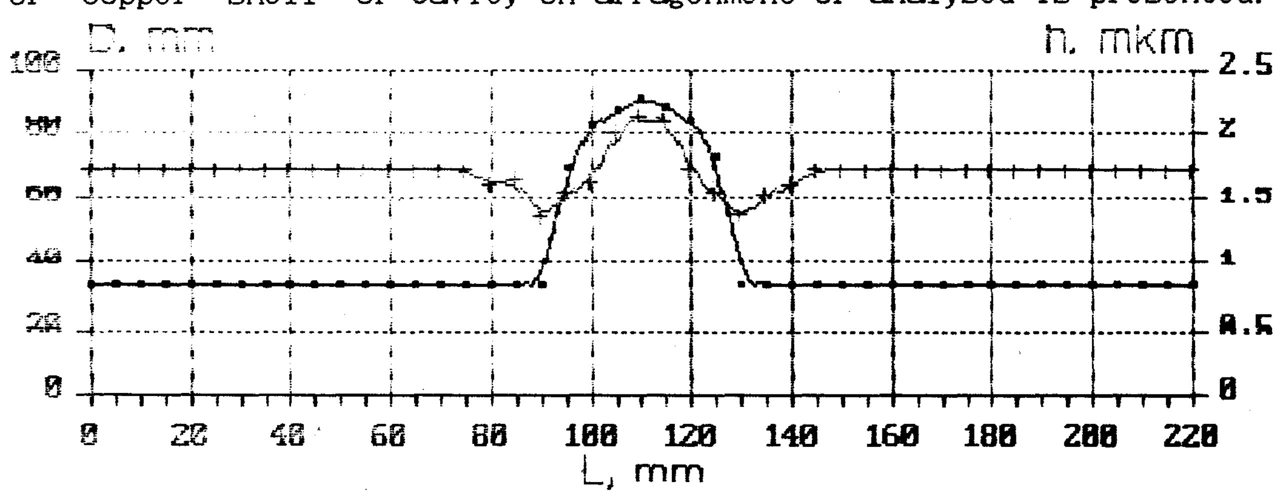

Fig.3 The dependence ofYBaCuO cover thickness on the arrangement of the analysed part on cavity working surface

The Tc depending on the technological factors and the kind of buffer layer is in the range of 68.34 to 90.27 K. The analysis of RF properties of YBaCuo film of different laboratories described in the works /4-7, 10-15,20-28/ shows the technology of the YBaCuO films as promising for accelerating RF accelerators.

7. Conclusion

Special attention is to be further dream by the autors to the influence of high vacuum annealing of the SC cavity working surface on the base of high Tc/ Cu to the emission properties and stability of electrophysical parameters of high Tc films.

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