Superconducting Microwave Cavities with a Nb_3Sn Layer Prepared by Electrodeposition

V.N. Kolosov and A.A. Shevyryov

Institute of Chemistry KSC RAS, 184209, Apatity, Murmansk region, Russia;
e-mail: orlov@chemy.kolasc.net.ru

Electrochemical deposition is a promising way of producing superconducting coatings for microwave application [1,2]. This paper deals with superconducting microwave cavity production with an electrolytic Nb_3Sn layer by galvanoplastics method.

At the first stage we studied the possibility of creating of mirror-like coatings having a stoichiometric composition and containing a minimal amount of impurities, as well as featuring good adhesion with the heat-conducting layer. The second stage consisted in designing a technology to produce working cavity models of varying configurations, and define the main production stages, their specificity and sequence. As a result, we have made brassboard cavity models on basic Nb_3Sn-Nb and Nb_3Sn-Nb-Cu compositions of diverse frequencies and sizes (Fig. 1-3). This involved the operations of matrix removal and depositing of heat-conducting layers of needed thickness. The third stage was the most challenging one. It was aimed at finding a relationship between cavity microwave characteristics and their production parameters. Initial measurements of cavity characteristics, with no machining whatsoever, immediately after electrolysis, have produced encouraging results. However, we attempted to improve them by elucidating:

- the state of substrate surface depending on the nature of matrix metal under similar conditions of the latter preparation;
- the utility of matrix thermal treatment prior to functional superconducting Nb_3Sn layer application;
- the relation between the methods of matrix surface preparation and chemical purity of Nb_3Sn working layer;
- the impact of Nb_3Sn-Nb composite thermal treatment on superconducting cavity microwave characteristics.

When creating a cavity by the galvanoplastics method we are concerned with composites of several layers. In the course of process stages, when applying every subsequent layer, as well as during the ready cavity operation, the latter undergoes a temperature exposure which brings about the emergence of tensions in the coatings, layer interaction, and the change of their strength- and superconducting properties. Therefore, one of our most important tasks is the search for such optimal conditions of resonator production and operation whereby the tensions are reduced to minimal possible values with an even distribution throughout the entire volume. The performed theoretical calculations and graphical dependencies obtained have yielded, with a certain approximation, an understanding of tensions in all the layers used in the composite depending on films thickness and their number, temperature, etc.

Thus, the research has disclosed the possibility of using electrolytical Nb_3Sn coatings to achieve acceptable microwave characteristics in superconducting cavity.

[1]. V.N. Kolosov and E.S. Matychenko. *Refractory Metals in Molten Salts*. Dordrecht/Boston/London: Kluwer Academic Publisher, p. 231-238 (1998).
[2]. V.N. Kolosov. *Ibid.*, p. 239-244.

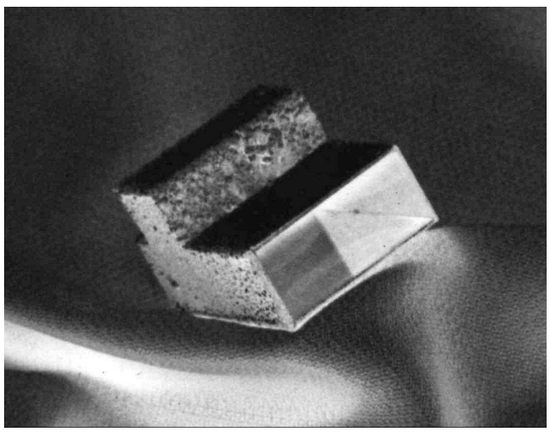

Fig. 1. Superconducting Nb_3Sn-Nb waveguide.

Fig. 2. Superconducting 4 cm microwave Nb_3Sn-Nb cavity

Fig. 3. Monocell superconducting Nb_3Sn-Nb-Cu cavity mode E_{010}.