新博士紹介

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Title: Spectroscopic Study of Surface Treatments for Nb SRF Cavity

1. Introduction

The International Linear Collider（ILC）will be operated at center of mass energy of 500 GeV [1]. In order to achieve such a high energy, ILC will use roughly about 15,000 nine-cell superconducting radio frequency（SRF）cavities. The field gradient per cavity should be higher as much as possible to built ILC cheaper and shorter. Currently the goal of field gradient of each cavity has been set to 35 MV/m.

Niobium（Nb）is the main material used for fabricating such SRF cavities. The manufacturing of a cavity from Nb ingots includes several processes hence the possibility of inclusion of contaminants at each step is greatly enhanced. After a cavity is produced, cavity inner surface is mechanically or chemically polished [2]. Thus the surface treatments [3] associated with SRF cavities are the key issues towards the achievement of high performances. Standard surface treatments at KEK involving mechanical polishing（MP）, buffered chemical polishing（BCP）, electro-polishing（EP）followed by various rinsing procedures such as ultrasonic rinsing in ultra pure water（UPW）, high pressure rinsing（HPR）and baking have been used to get smooth and contaminant-free surface. Among them EP followed by HPR [4] has revealed good potential to reduce surface roughness and mitigate the contaminants therefore it is of much interest to investigate the EP and HPR behavior in details on Nb surfaces.

2. Electropolishing experiments

In order to investigate the performance of EP based on different operating conditions we conducted several experiments with different conditions by using real single cell Nb cavity and on laboratory coupons. In the experiments with real Nb cavity, a single cell Nb cavity was drilled with six holes at three critical positions: equator, iris and beampipe（**Fig. 1**）[5]. The disc type Nb samples of the same diameter as of cavity holes were mounted to the cavity holes. This Nb cavity assembled with samples was then electropolished（EPed）at Superconducting Test Facility（STF）, KEK in the routine manner as ILC cavities are EPed. After the EP, cavity was moved to clean room and samples were carefully detached. These samples were kept in a vacuum suitcase in order to avoid any further contaminations from the atmosphere. In the experiment at laboratory scale, some rectangular type samples were fixed on a Nb base plate [6]. This Nb base plate along with samples was then EPed at lab EP facility.

3. Rinsing/Cleaning Experiments

As HPR is one of the most important rinsing

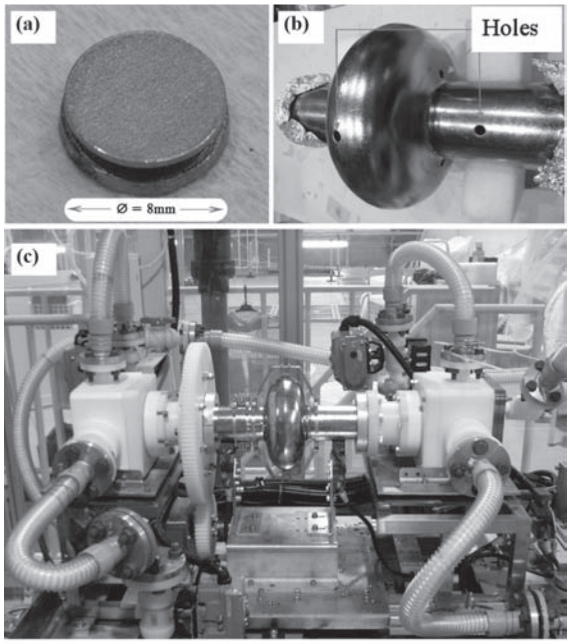

Fig. 1 Preparation of EP at single cell cavity with samples, (a) Sample used for EP, (b) Nb SRF cavity drilled with three pairs of holes at critical positions "equator", "iris" and "beam pipe", (c) Single cell cavity assembled with samples at EP bed.

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procedures after the EP, we also conducted a series of HPR experiments on laboratory coupons with different conditions. For the experiments, a general high pressure machine was used and different pressure can be selected by using a knob of machine. The experiments were conducted with three different pressures and two doses (rinsing time) for each pressure. An experimental setup was designed which containing a slide rail on which sample was fixed and dose could be controlled[7]. Beside HPR, the dry ice cleaning was also performed on sample surface. The same system of HPR was used for dry ice cleaning.

4. Surface Analyses

After the experiments, all the sample surfaces were characterized by using a surface analysis system (**Fig. 2**). The surface analysis system[5,6] is maintained at extremely high vacuum (XHV) and can be connected to the UHV suitcase via three loadlock chambers. The samples can be transferred from the suitcase to the analysis chamber with the help of these three loadlock system without exposing them in to the air. The analysis system is capable of executing Auger electron spectroscopy (AES), secondary ion mass spectrometry (SIMS) with argon ion etching and XPS with probing area of 2 mm. The XPS was mainly utilized to investigate the chemical state of the elements (this information is given by chemical shifts in the peak energy positions in the spectrum) and the elemental composition present on the samples surface[8]. The scanning electron microscope (SEM) was also used to observe the surface morphology

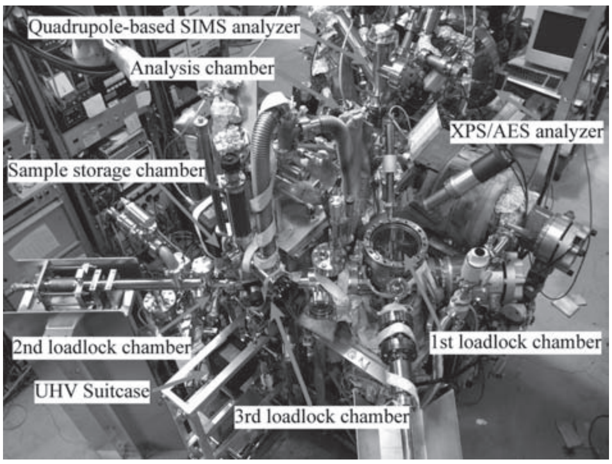

Fig. 2 An analysis system connected with an UHV suitcase via three loadlock chambers. It's base pressure is maintained of the order of 10^{-9} Pa.

of treated samples.

5. Summary of my thesis work

An approach has been made towards the understanding of surface treatments of Nb cavities with the help of special surface analytical tool. During the last three years of my PhD work, I have found several facts from our experiments for the first time in the world. Our EP experiments enabled to find the pros and cons of the existing EP process and could lead to suitable operating parameters for the process whereas HPR experiments could reveal the real facts of the process and would be very useful for SRF point of view. My work has mainly contributed to the R&D program of ILC cavity at STF, KEK. This will help to standardize the surface treatment process of ILC cavity.

6. Future work

For the future researches, I want to continue my studies on surface preparation and investigations with the help of surface analytical tools. The development of new surface treatments[9] and establish them for Nb SRF cavities is very interesting for me. I also gathered much experience with surface coatings along with surface analysis also make it possible for me to work in surface coatings area.

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