European Coordination for Accelerator Research and Development

PUBLICATION

New thin film techniques for SC cavities and photo cathodes

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DELIVERABLE REPORT

NEW THIN FILM TECHNIQUES FOR SC CAVITIES AND PHOTOCATHODES

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Abstract:

The EuCARD monograph 12, ¨Materials and surface aspects in the development of SRF niobium cavities¨ is a comprehensive review on the state of the art materials and material preparation for SRF cavities, and includes a chapter on state of the art film technology, paving the ground for future research and development.

This chapter focuses on innovative multi-layered films to overcome materials limitation at high field, and on innovative coating technologies for traditional materials, and is the basis for the future Thin Film Task in Eucard-2.

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Delivery Slip

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1. EXECUTIVE SUMMARY

This deliverable report has been expanded to cover the whole superconducting RF field, as published in the EuCARD monograph 12 "Materials and surface aspects in the development of SRF niobium cavities", Claire Antoine, 2011, 130 pages.

It describes the main phenomena related to surface and material properties involved in SRF technology. Each chapter begins with basic observations, followed by some discussion based on experimental results obtained with advanced material/surface studies techniques. The purpose of these discussions is to familiarize the reader from the accelerator community the possibility of these techniques, to draw attention to some remarkable results, but also give some hints about the limitations of each technique.

After a brief introduction describing the philosophy of Niobium cavity fabrication and preparation, there is a large chapter dedicated to niobium metallurgy, mechanical properties, forming... The physical origin and the influence of these parameters to the specifications are described so that the reader should be able to knowingly change the specifications whenever his application requires it. Topics like large grain cavities, damage, dislocations influence on superconducting properties, etc. are discussed. The next chapter discusses surface morphology in relation to surface treatments and its possible influence on cavity performances. A large chapter is then dedicated to sub-surface contamination, mainly hydrogen and oxygen, at the metal-oxide interface. The role of this interface in superconducting properties, in particular its modification upon baking is discussed.

Before the conclusion, a prospective chapter is dedicated to after-the-niobium superconductors, in particular the multilayers structures proposed by Gurevich. It focuses on innovative multi-layered films to overcome materials limitation at high field, and on innovative coating technologies for traditional materials, and is the basis for the future Thin Film Task in Eucard 2.

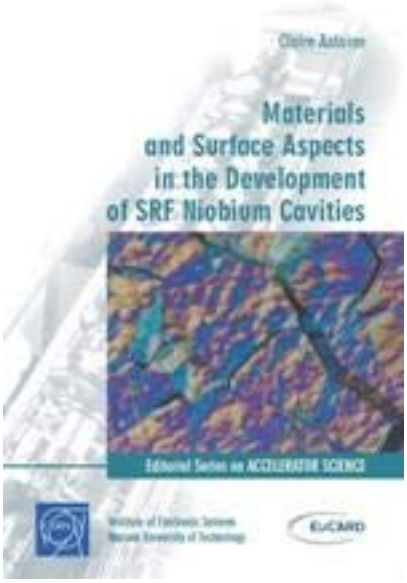
Other useful information is gathered in appendixes: main issues concerning particle contamination and field emission, main features and description of surface treatments, and information on niobium machining and hydroforming. A glossary and more than 220 references entries complete this work.

2. INTRODUCTION

Quoting from the conclusion of the book: ¨We also see that next generation SRF materials (thin films, multilayers) are about to emerge and strong R&D activity could lead to a breakthrough in this technology after several decennia of bulk Niobium monopoly. I hope our community will seize this opportunity and will go on being dynamic and productive¨. This statement is based on extensive studies of past and present major achievements in SRF and an analysis of the limitations of current materials.

Emerging technologies such as multi-layered films, energetic condensation techniques, new materials are analysed in the book, and a solid motivation for further studies within EuCARD2 is laid down.

3. THE BOOKLET



Materials and surface aspects in the development of SRF niobium cavities

Claire Antoine, 2011, 130 pages

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http://eucard.web.cern.ch/eucard/activities/communication/booklets/#Vol12, with the full text pdf version at https://cds.cern.ch/record/1472363/files/EuCARD-BOO-2012-001.pdf

4. FUTURE PLANS

As already mentioned, a new Thin Films task within EuCARD2 will address:

- Investigate improving the performance of Nb coatings
- Develop new superconductors, both Nb3Sn and multilayer
- Develop new measurement techniques, for characterisation of RF and material properties