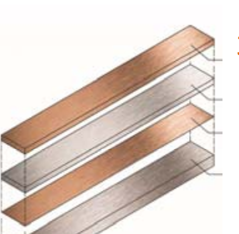
Work Package 7 - Advanced superconducting techniques for particle accelerators

Objective O7.3: ***Optimize state-of-the-art electrochemical techniques for Nb3Sn thin layer deposition on Nb and on Cu***

APPROACH I
Electrodeposition + annealing

Electrodeposition of **Cu/Sn/Cu multilayers** from aqueous solutions onto **Nb + Thermal treatment** for Sn-Nb interdiffusion



3. Copper barrier
2. Sn
1. Copper strike
Nb substrate

Copper barrier
- ✓ Prevents Sn leakage during TT
- ✓ Compact structure of samples

Copper strike gives
- ✓ Lower Nb_3Sn formation T
- ✓ Higher grain boundary density
- ✓ Good adhesion
- ✓ Higher growth rate

APPROACH II
Direct electrodeposition

Electrodeposition of **Nb-Sn** alloys onto **Cu substrates**

IONIC LIQUIDS
- **EMIM**: 1-Ethyl-3-methylimidazolium chloride
- **BMIM**: 1-Butyl-3-methylimidazolium chloride

High $NbCl_5$ **solubility**
Higher **Nb content** in the coating

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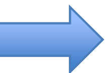
State of the art at Polimi

I. 2012 Master thesis

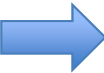
Electrochemical synthesis of Nb-Sn coatings for High Field Accelerator Magnets (Federico Reginato)



US Patent "Synthesis of superconducting Nb-Sn" (Polimi, FermiLab)

II. 2014 Master thesis

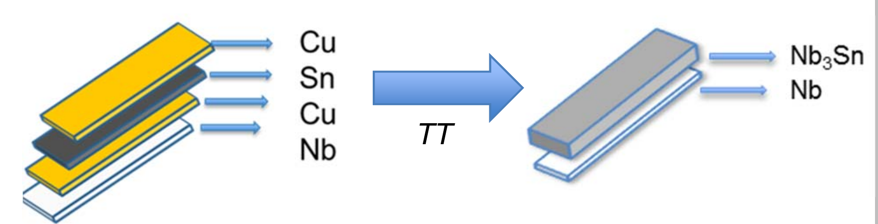
Electrochemical Synthesis of Nb-Sn Coatings from ionic liquids (Luigia Glionna)



Previous results were not reproduced

Activities mentioned in O7.3

1. Improve adhesion of the film
2. Optimize thermal treatments
3. Achieve the best uniformity of the deposit across both flat and curved surfaces
4. Increase purity



Activities planned (months 3-21)

a. Update of state of the art on Nb-Sn coatings obtained by electrodeposition
b. Reproduce previous results with respect to:
    a. Optimization of etching procedure to achieve good adhesion to the Nb substrate
    b. Avoid corrosion problems
    c. Avoid undesired barrier diffusion layers during thermal treatment
    d. Optimization of thermal treatment of Cu/Sn/Cu multilayers onto Nb substrate

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First generation samples

Cu *3*
Sn *2*
Cu *1*
Nb

Thermal Treatment

Nb_3Sn
Nb

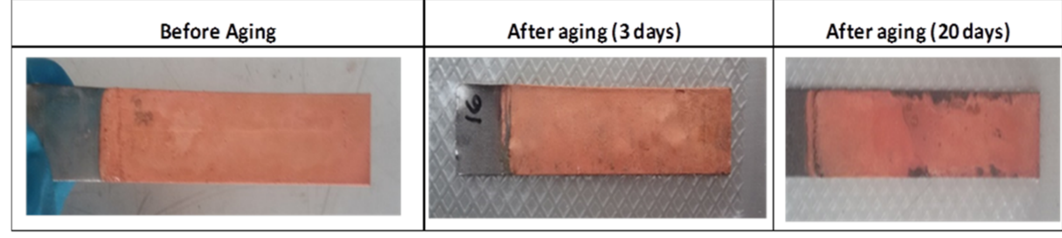
Presence of Nb native Oxides

- Weakens the adhesion of layers
- Acts as barrier layer during thermal treatment
- Hinders the formation of Nb-Sn alloy

Electrodeposition of Cu1

1. ***Etching***
2. *Washing*
3. *Galvanic deposition*

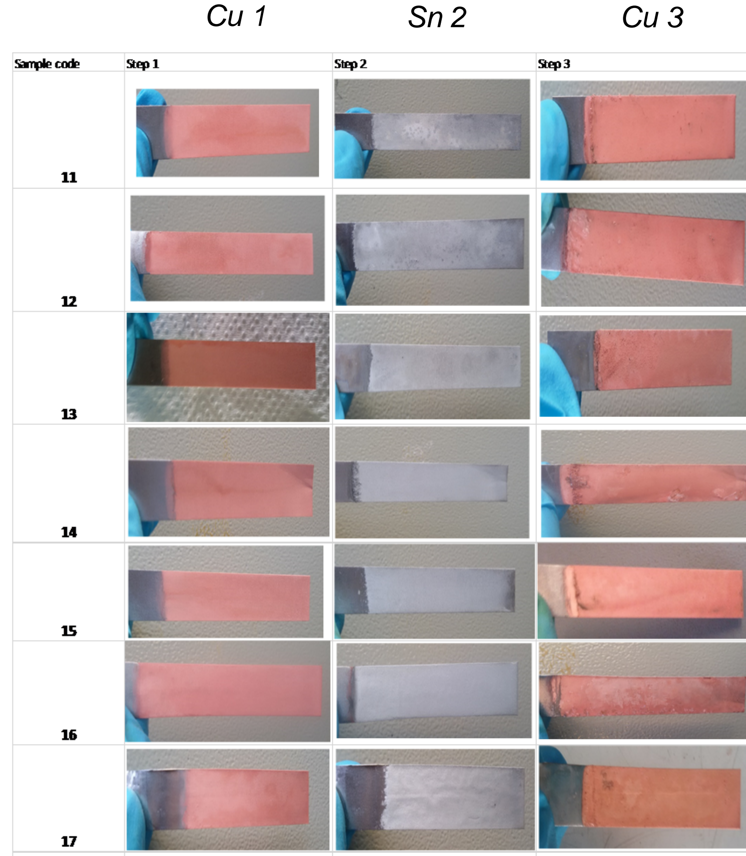
Etching **85% H_3PO_4: 49% HF: 70% HNO_3 2:1,5:1 (vol)**



Corrosion due to etching solution residues

The deposition process is reproducible

Cu 1 *Sn 2* *Cu 3*



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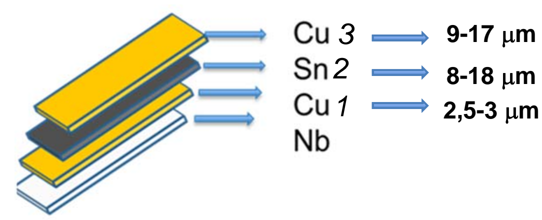
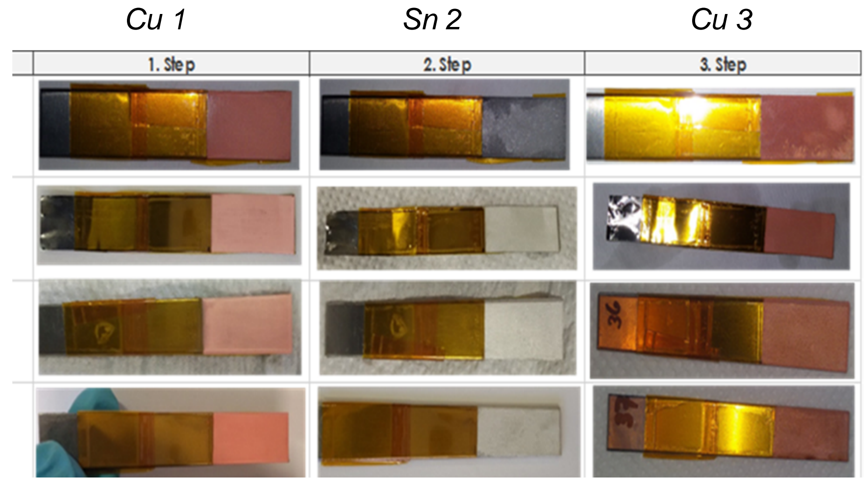
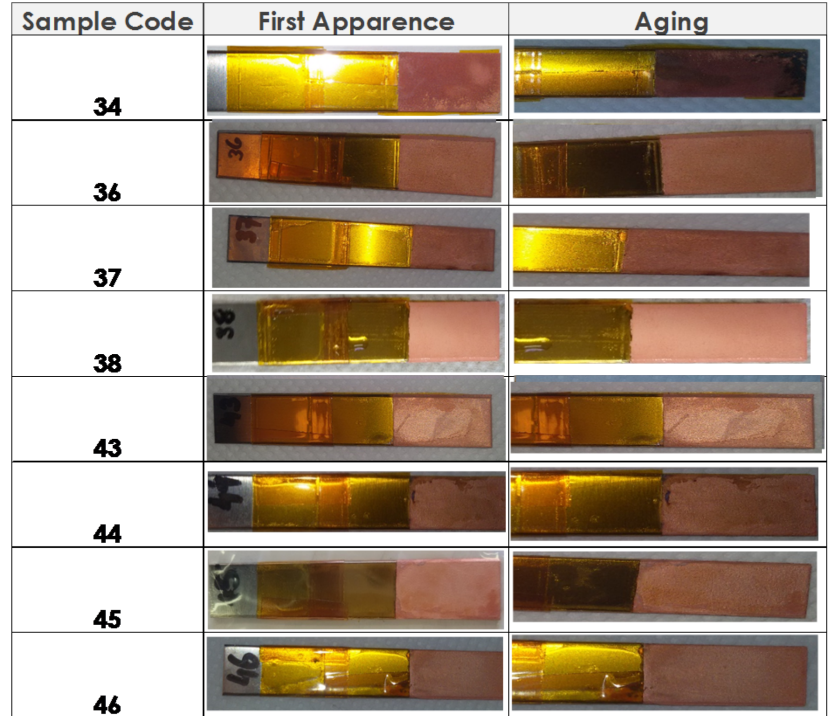
Second generation samples



Etching **30% HF**



No corrosion observed after >1 month aging



Sample Code	First Apparence	Aging
34		
36		
37		
38		
43		
44		
45		
46		

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