PhD subject – Labex CEMAM
Insulating/supraconductive Nanostructured Multilayers
MULNIS

This project concerns the application of niobium based materials for radiofrequency superconductivity, and, particularly, the behavior of superconducting material submitted to intense fields for particles acceleration purpose. Up to now, only bulk niobium can successfully sustain very high accelerating field but it has reached its ultimate limits (in terms of transition field). Recent theoretical work allowed bringing satisfactory explanations about the relative failure of other type of superconductors and proposing new composite structures that benefit from the exceptional properties of superconducting films with nanometer thickness. These composite structures consist in insulating/supraconductive multilayers of few nanometers thickness. A first experimental study allowed to demonstrate the predicted effect on model samples deposited onto monocrystalline substrates.

The objective of our study is to develop a multilayered architecture by Plasma Enhanced Atomic Layer Deposition, which is the most appropriate technique to deposit nanometer thick layers onto substrates with complex shape. The multilayered structure will be formed of the NbN supraconducting material and AlN as insulating layer. The structural, morphological and functional properties will be optimized for performance of cavities (RF). Simulation of the thermomechanical properties will be also used to optimize the deposited structure. These structures will be realised onto metallic substrates, representative of accelerating cavities fabrication processes.

Manufacturing multilayer structure for coating the accelerating cavities requires following specifications:

- Deposit of nanometer layers on niobium superconducting material in a RF cavity geometry type (elliptical convex inner surface) with excellent control of the thickness of the structure. Deposit of nanometer layers of insulating material.
- Optimization of the stack (number of layers, thickness ...): model validation
- Optimization of the stack (number of layers, thickness ...) from a structural point of view, thermodynamics and thermomechanical .

The work will be done in the CEMAM Labex (http://cemam.grenoble-inp.fr/cemam/) framework in Grenoble at SIMaP in collaboration with LMGP. RF testing of accelerating cavities will be performed at CEA Saclay.

The candidate should have strong knowledge in materials science, chemistry, and experience in thin film deposition and characterisation techniques.

Contact people:

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