ABSTRACT

Among all the different fields of the Nuclear and Particle Physics, the research on neutrino-related topics is recently gaining more and more attention. The precise assessment of the neutrino mass is of extraordinary importance in theory elaboration. The same experiments that measure the neutrino mass are also focusing their efforts in detecting a Neutrinoless double β-decay ($0\nu\beta\beta$), a rare event in which two neutrinos annihilate each other. If observed, the consequences would deeply affect various branches of the current Modern Physics, from Nuclear Physics to Cosmology; for instance, it'd prove the Majorana nature of the neutrino (i.e. to be its own antiparticle), deny the conservation of the lepton number, shed light on the abundance of the baryonic matter over the antimatter in the universe. As one can easily imagine, the potential of this discovery is enormous, yet there are several important issues to face. Two of them are the considerably long half-lifetime of the process (more than 10^{24} years) and the uncertainty in the Nuclear Matrix Element evaluation, due to the lack of experimental data. The latter was the reason for which the NUMEN experiment was conceived. The goal of the NUclear Matrix Elements for Neutrinoless double β-decay (NUMEN) Project is to measure the cross-section of Double Charge-Exchange (DCE) reactions, whose initial and final states are analogous to the ones involved in $0\nu\beta\beta$ decays. However, this is not an easy task: a DCE event is more probable than a $0\nu\beta\beta$ decay, but it is itself quite rare with respect to competing processes; moreover, a considerable amount of data needs to be collected to have a good statistics. For these reasons, NUMEN will use intense ion beams of tens of μA, which will react with targets made of special isotopes of different materials. Such targets will be shaped as thin foils to preserve the resolution in the energy measurements. But from the combination of these two factors, a new problem arises: due to the energy deposited by the beam in the targets, the latter undergoes a strong thermal stress, eventually being irredeemably damaged.

The aim of the work presented in this thesis is to provide a possible solution to such problem, producing thin targets resistant to intense ion beams. In order to mitigate the excessive temperature rise, in addition to a cryogenic cooler, the targets can be deposited on a high-thermally conductive substrate, whose contribution had, however, to be evaluated. For this purpose a code written in MatLab language has been developed; the code is able to track the temper-

ature evolution in nanoseconds steps, up to the steady state regime for the target/substrate system. Also the software COMSOL has been used, in order to analyze the contribution of the sample holder, taking advantage of the 3D model analysis. Both of the programs proved the solution to be suitable.
Pyrolytic graphite has been chosen as substrate, for its outstanding thermal and mechanical properties. The films, deposited by Electron Beam Deposition, must meet demanding requirements about homogeneity, both in density and thickness. Hence, the produced targets were thoroughly analyzed with a Field Emission Scanning Electron Microscope, until satisfactory results were achieved.
Finally, using a LASER and ion beams as heat sources, the targets thermal behavior has been tested. The LASER test was aimed at studying the dissipation capability of the target/graphite system alone; the ion beam test, performed at UNAM, involved a cooling system in a vacuum chamber and aimed at studying the target/graphite/sample holder system. For both of the tests, results were in good agreement with expected data.