Window Design for the TASCA Recoil Transfer Chamber (RTC)

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In 2006, commissioning of the TransActinide Separator and Chemistry Apparatus TASCA [1], dedicated to investigate the chemical and physical properties of the heaviest elements, has started. One of TASCA's main foreseen applications is the use as a physical preseparator for chemical studies [2]. In this technique, EVaporation Residues (EVRs) are separated from the heavy-ion beam and from a significant fraction of unwanted byproducts of the nuclear reaction used to synthesize the element of interest. EVRs are extracted from the separator through a thin window. This separates TASCA's low-pressure region from the Recoil Transfer Chamber (RTC) in which EVRs are thermalized and made available for transport to a chemistry setup. This approach promises to allow significant progress in the chemical investigation of the heaviest elements as new techniques and new chemical compound classes become accessible for experimental study [2-4].

The RTC window that separates two different gas pressure regimes (~0.1-2 mbar inside TASCA, up to 2 bar in the RTC) has to meet the following requirements: i) He gas tightness at a pressure difference up to 2 bars, ii) small window thickness down to 100 µg/cm^2. The first RTC prototype has been built in Berkeley [5] for chemical studies of Rf [3] produced in cold fusion reactions. The high Rf recoil energy has allowed using a 6-µm or a 3.3-µm thick Mylar foil on an aluminum support grid with 90% or 80% transparency, respectively. An RTC with a thinner Mylar window (2 µm) has been successfully tested at the gas filled separator GARIS (RIKEN, Japan) [6]. However, production of longer-lived, more neutron-rich transactinides requires using hot fusion reactions with actinide targets. The products of such reactions are so slow that their recoil ranges are very short. Therefore, more advanced, even thinner windows as well as appropriate support structures need to be developed.

TASCA features two ion-optical modes leading to different EVR images in the focal plane [7]: the High Transmission Mode (HTM) has maximum transmission but a relatively large image in the focal plane. About 80% of the transmitted EVRs of the "design reaction" ^{48}Ca+^{238}U are deposited inside an area of ~(140x40) mm^2. Reversing the polarity of the TASCA quadrupole magnets leads to the Small Image Mode (SIM) with a small image of ~(30x40) mm^2 at the cost of a somewhat reduced transmission. For reactions leading to relatively short-lived isotopes ($T_{½}$ ~s), the benefit of a small image size is expected to outweigh the loss in transmission.

The RTC window design is based on a standard Stainless Steel (SS) Conflat® flange with a nominal diameter of 150 mm. The maximum size that can be accommodated by this flange has been chosen for the HTM and is (140x40) mm^2. The window size for the SIM is only (30x40) mm^2. The RTC window is supported by a honeycomb structure with 0.3 mm wide spokes and a hole pitch of 2.9 mm. It was made from hard SS by laser cutting. The outer grid dimensions are (144x44) mm^2 for the HTM and (34x44) mm^2 for SIM. The geometrical transmission is 80% (Figure 1a). To minimize losses due to non-parallel EVR trajectories, the grid has a thickness of only 1 mm. Because of the large working load on the large HTM window (up to ~100 kg), two bars were implemented in the flange to support the grid (Figure 1c). For ultra thin windows, a 20-µm thick Ni mesh with square (0.3x0.3) mm^2 holes and 20 µm wide spokes (Figure 1b) can be put on top of the metal grid. It has a transparency of 90% and was made by electro-etching. For aluminized Mylar foils with thicknesses of 1.5 µm or more, using the coarse grid only should be sufficient.

The windows for both, the HTM and the SIM, were successfully tested with Hg and Pb isotopes produced in ^{40}Ar induced reactions [8].

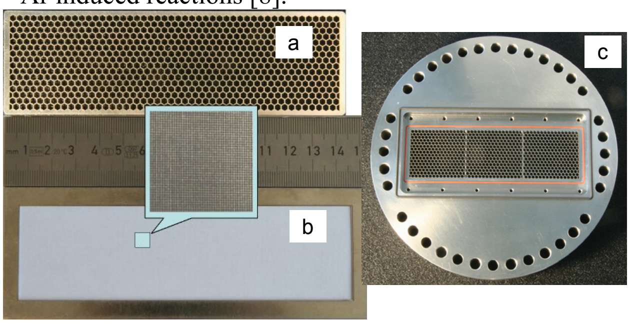

Figure 1: The honeycomb structure grid (a), the ultra fine Ni mesh (b) and the flange for the HTM (c).

References

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