Status of the Target Ion Source for MAFF

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The central in-pile part of MAFF [1], the very compact (about 15 cm length, 8 cm diameter) target ion source, is currently under development. The source will be mounted on a supporting rod and remotely controlled placed at the point of maximum thermal neutron flux (about $1.5*10^{14}$ n/cm^2s), at 60 cm distance to the reactor core inside the through-going zircaloy beam tube SR6 at the new Munich high flux reactor FRM II. After a reactor cycle of 52 days, the activated source will be removed, stored safely and replaced by a new one. These steps will be executed remotely contolled, too. With a load of 1g ^{235}U, 10^{14} fissions/s will be triggered. By thermal neutron induced fission, masses between A=70 and A=160 can be produced. Several types of ion sources are required to cover the elements in this mass range. In the first instance, the most simple ion source for surface ionization mode (production of 1+ charged ions) based on the ANUBIS source at the OSIRIS facility in Studsvik [2] was constructed. The surface ionization source provides ionization efficiencies of about 100% for alkaline metals.

Some modifications have been made to the ANUBIS design in order to master the operational conditions. Much effort was spent on the development of appropriate uranium-carbide targets [3]. At low U concentration, the target will be externally heated with a tungsten filament by electron bombardment and so kept at a temperature of about 2400°C, which provides rapid effusion of the fission products into the target channel. The target is surrounded with a cylinder made of glassy carbon and a protective rhenium container, at the outlet of which surface ionization takes place. Re has been chosen, because it is most inert against C and U at high temperatures, has a high melting point (3180°C) and can withstand the high neutron flux best. Several heat shields are supposed to confine the high temperature in the centre of the source: Three disks with openings for the feedthroughs towards the first ceramic insulator, four concentric tubes and one disk towards the front side, facing the outlet of the target container. Although Re does not show optimum neutron capture properties, the two innermost heat shields and bottom covers as well as the inner front cover will be manufactured out of Re. Nb and Mo are no alternatives for these strongly temperature-stressed parts because of their comparatively low melting points, W and Ta should be avoided because of their long-term nuclear activity after a reactor cycle [4]. Most of the other parts can be made of Mo (see Fig. 1). Effort has been put into the optimization of the ion extraction. The first acceleration stage consist of a two-electrode extraction system. The first extraction electrode, together with the front heat shield, works as an electrostatic lens and forms the ion beam, while the second extraction electrode does most of the acceleration [5]. The target has a potential of 30 kV with respect to the beam tube and the second extraction electrode, so that the ion beam is accelerated up to 30 keV (the two front covers have potential differences in the order of magnitude of 1kV with respect to the target). The second extraction electrode is mounted on another supporting rod, which is driven into the beam tube from the opposite site. These electrostatic elements will not be exchanged after each reactor cycle. The beam dynamics has been intensively simulated using the code IGUN(C) as well as the shape of the electric potential between the filament and the target container to provide homogenous bombardment of the Re container. At the moment, the influences of possible radial displacement of the optics on the beam and techniques to correct them are under investigation. By using proper correction electrodes, it seems possible to handle a displacement of up to 5 mm with a emittance of 9.7 π*mm*mrad.

A stainless steel model of the source with a Ta target container and the original BeO insulators has been manufactured (see Fig. 2). This model will be mounted inside of a test vessel with identical diameter and wall thickness like the SR6 beam tube. With this arrangement, the mechanical and thermal characteristics of the source can be tested, as well as the target behaviour, which will be tested without load and with a non-radioactive load, e.g. Na. The tests are expected to begin in spring 2002. Afterwards, the beam dynamics will be tested and optimized at the source test unit of the TANDEM accelerator lab, before the dummy will be replaced by a prototype made of the projected materials.

References

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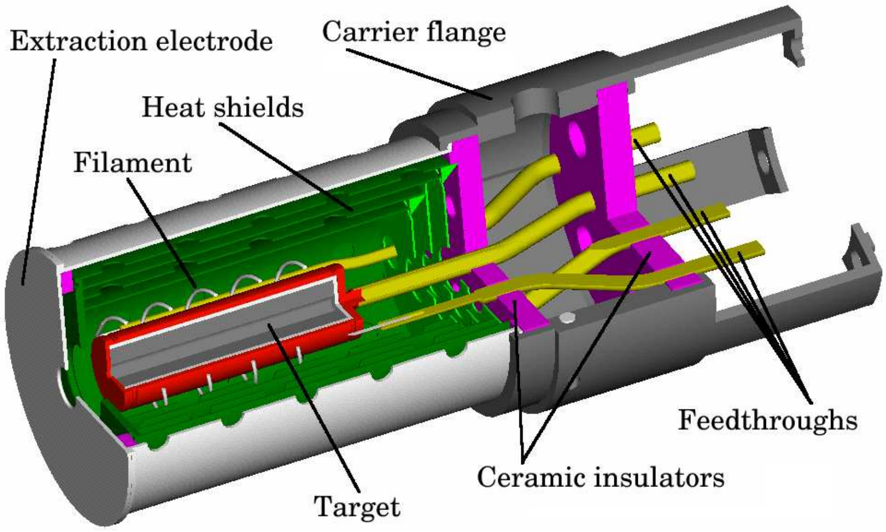

Fig. 1: Schematic view of the MAFF ion source model

Fig. 2: Photographic view of the MAFF ion source model