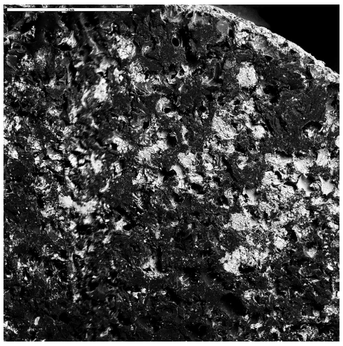
MAFF Fission Target Development

H.-J. Maier, D. Habs, M. Groß, R. Großmann, O. Kester, F. Ospald, and P. G. Thirolf

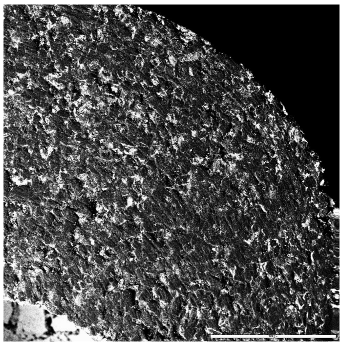
The MAFF fission target consists of 99 % enriched $^{235}UC_2$ dispersed homogeneously in a porous carbon matrix, which has the shape of a cylinder of 15 mm diam. and 60 mm length with a narrow, coaxial, single-ended channel of 5 mm diam. and 55 mm length. The carbon cylinder is mounted in a protecting Re sheath having a 2 mm diam. aperture in front of the channel, allowing for extraction of the beam of the ionized fission fragments. A typical ^{235}U load is 1 g, leading to 10^{14} fissions s^{-1}.

Doping of a carbon matrix with U is performed by immersion in a highly concentrated aequous solution of $UO_2(NO_3)_2$ [1,2]. Dehydration and subsequent heating in vacuo up to 1500 °C converts the absorbed $UO_2(NO_3)_2$ into UC_2.

The knowledge of the U content of the target is crucial for the operation of the MAFF ion source. It is determined routinely from the weight of the sample right after dehydration. Since this method is afflicted with a systematic error resulting from a possible fraction of residual water, it was cross-checked by combustion of a number of random samples in a pure oxygen atmosphere. Here, the carbon is removed in form of CO_2, leaving a solid residuum of U_3O_8, from which the exact value of the U content can be calculated. This leads to a correction factor of 0.9–0.95, depending on the specific carbon type.



POCO Foam



UCAR PG 100

Fig. 1: SEM micrographs showing the dispersion of U in two different carbon samples. The white points represent the U deposit in the black carbon matrix.

So far, six different types of carbon have been investigated for their capability of incorporating U at a sufficient quantity and a sufficiently homogeneous dispersion. The results are shown in table 1 and fig. 1. Sample R7141H is a non graphitized, so called hard carbon material of comparatively low density and was found to have the poorest performance with respect to the projected application. Samples CBY and MKLN are standard extruded graphite materials with promising porosity figures, which are designed for applications as electrodes, heat exchangers, moulds, crucibles, etc. These materials are cheap and readily available and were used to study process variants like pressure- and twice impregnation. Samples PG 100 and PS are highly porous graphites made for use as filters or catalysts. POCO Foam is a recently developed graphite foam, which can be cut with a knife and exhibits an exceptionally high porosity.

Carbon Type/ Supplier	Density g/cm^3	% Open Porosity	mg U in C	at.% U in C
R7141H/SGL	1.55	18	645	0.22
CBY/UCAR	1.63	21	697	0.22
			796[a]	0.25
MKLN/SGL	1.64	20	739	0.24
			867[a]	0.27
			1375[b]	0.44
PG 100/UCAR	1.04	53	1242	0.56
PS/POCO	1.35	40	1420	0.52
Foam/POCO	0.4	58	1313	2.55

Table 1: Absorption of U for different types of Carbon

[a]pressure enhanced impregnation
[b]twice impregnated sample

It can be concluded from table 1, that the required load of 1 g U can be achieved with all of the six investigated carbon types by chosing a proper concentration of the doping solution and applying either single or twice impregnation. However, the qualification as a fission target requires in addition a homogeneous dispersion of the fissile material in the carbon matrix. A qualitative view of this dispersion can be obtained by inspection of a transverse cut across the target cylinder in a scanning electron microscope. If the electron backscattering mode is applied, the U particles appear in white color on the black carbon background. In Fig. 1, such electron micrographs are shown for the two most different samples. POCO Foam, which is characterized by the highest absorption capacity for U, exhibits the worst dispersion. In contrast, the most homogeneous dispersion was found for the UCAR PG 100 sample. Keeping in mind, that its absorption capacity for U is excellent as well, UCAR PG 100 is the most promising graphite matrix for application in the MAFF ion source.

References

[1] H. J. Maier *et al.*, Annual report 1999, p. 110
[2] H. J. Maier *et al.*, Annual report 2000, p. 76