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Radioactive ion beam production at CERN-ISOLDE with nanometric, highly porous target materials – a review

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After isotope production, in the bulk of the target material, the beam intensities in ISOL facilities are mainly defined by: the release from the target material, ionization, mass separation and transport efficiencies. Although production can be up to 1E10 /s, by far the most limiting step is the release of the isotopes from the target itself, where release efficiencies can go down to 1E-6 or even less, especially in the case of very short lived isotopes. Apart from this, beam intensities are sometimes decreasing over time, which can be due to the target material degradation. For those reasons, the target material research at ISOL facilities is crucial to deliver stable, high intensity and new exotic beams. The stabilization of open porous, nanostructured materials at high temperatures is the key to improve release efficiencies by reducing the isotope diffusion times, assuming this process is limiting the release.
The nanomaterial target family[1] at ISOLDE has been extended, with novel nano materials operated last year. Nano calcium oxide [2,3] has been operated and has delivered significant intensities of 31Ar even at room temperature. A new material was added to the ISOLDE target material collection - titanium carbide and carbon black nanocomposite [4] - which displayed no decrease of yields as opposed to the previously used Ti foils targets. For the first time, a target exclusively made of multiwall carbon nanotubes (MWCNT) was operated and showed indications of the first 8B beams.
With ~70% of the beam time at ISOLDE, the development of uranium carbide with excess carbon (UCx) target represent the most significant gains for the facility. A composite made of UCx and MWCNT was developed, showing high and stable yields on almost all measured isotopes [5]. Using the same recipe, a nanometric lanthanum carbide-MWCNT composite was successfully developed and tested to provide high and stable beams of neutron-deficient Ba and Cs isotopes.
These materials will be reviewed in terms of synthesis, material characteristics, time-structure and release rates of selected isotopes. From the release results the modelling of physical parameters (effusion and diffusion) will be shown [6].

References

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