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Development of new radioactive beams

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A R&D program is developed at the ALTO facility (Accélérateur Linéaire et Tandem d'Orsay) at the Institute of Nuclear Physics of Orsay (IPNO) in order to provide new beams of exotic neutron-rich nuclei, as intense as possible. The production of such beams will allow performing crucial experience for the increase of our knowledge in the field of the nuclear physics. At ALTO, the neutron-rich nuclei are produced by photofission in thick actinide targets that are the subject of a R&D program. To improve the intensities of radioactive beams, in particular those formed by short-lived isotopes, two ways of research are explored. In the first one, the purpose is to develop dense and porous actinide targets, two properties a priori antagonistic but necessary to increase respectively the amount of fission fragments produced and their diffusion out of the target. In the second one, specific chemical processes are used to improve the release of refractory nuclei. In the framework of European projects, recent results have demonstrated the possibility to obtain beams of nuclei unreachable up to now using refractory targets with a nanoscaled structure. The improvement of such targets requires the control of the microstructure of the material prepared by reactive sintering and a systematic study of parameters such as temperature, pressure, sintering time and their effects on the stabilization of the obtained structure. In-beams experiments will establish the correlation between structural properties of the targets and the intensity of neutron-rich nuclei beams obtained by irradiating the target with ALTO. Various physicochemical phenomena are involved in the release process of neutron-rich nuclei produced in a thick target heated at high temperature (around 2000 ° C). A variety of chemical reactions (fluorination, sulfidation …) can be exploited to improve the release of refractory nuclei. Thus, the latter work at ALTO showed efficient production of rare-earth molecular ion beams obtained with a fluorination process. This type of approach will be developed to produce other ion beams of refractory elements, such as iron or cobalt. Calculations and modeling would support the experimental method, in particular to optimize the microstructure of the target leading to the optimum intensities of fission products.

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