Industrial Application of Accelerator : Medical RI Production

Kentaro Harada,
KEK-PF

Single photon emission computed tomography (SPECT) is a medical diagnostic tool widely used for cancer surveys. An image of the diseased part can be acquired using 141-keV gamma rays emitted from ^{99m}Tc, which is a radioisotope (RI) with a half-life of 6 h. ^{99m}Tc is the decay product of ^{99}Mo, which has a relatively long half-life of 66 h. Presently in Japan, the supply of ^{99}Mo depends on imports from foreign countries where ^{99}Mo is produced by the uranium fission in nuclear reactors. Because most of these reactors are aged, the international trades of uranium have difficulties due to the nuclear security, and the management of Plutonium waste is not easy, nuclear reactors based production seems not to be sustainable for long term. In Japan, domestic production is essential and recent accelerator technology seems very promising. The accelerator-based commercial ^{99}Mo production, for example, began in Canada 2014[1] with normal conducting electron LINAC. In Japan, similar accelerator system is under construction from 2019[2]. While the high current continuous wave (CW) beam is impossible for the normal conducting electron LINAC, Rhodotron[3] and superconducting electron LINAC can realize such beam parameters. RI production project with 40 MeV and 3 mA Rhodotron began in USA 2019[4]. In KEK, the basic experiment of the 99Mo production from the natural metal molybdenum was conducted at cERL with 21 MeV and 10 μA CW electron beam from 2018.

With CW high current accelerator, the electron beam power itself is almost enough for commercial mass production. In order to avoid the concentration of the heat load, however, the larger target size with widely spread electron beam is required for realistic system. Thus the relative radioactivity is much lower with accelerator-based production than that by the nuclear fission. The design of the optimized target system and the treatment of the produced RI material of the low relative radioactivity are the main subjects to be solved. From the results of the experiments, it is expected that several commercial superconducting accelerator systems with 20 MeV and 10 mA electron beam will be able to fulfill all Japanese demand.

The irradiation beamline and target system at cERL are supported by Accelerator Inc. The research is a joint project with the Chiyoda Technol Corporation and Fuji Film Toyama Chemical Co.,Ltd.

[1] M.S. de Jong, “Producing Medical Isotopes Using X-Rays”, Proc of IPAC2012 (2012) 3177
[2] Jaewoong Jang, et.al., “Design and testing of aW-MoO_3 target system for electron linac production of ^{99}Mo/^{99m}Tc”, NIM A 287 (2021) 164815
[3] https://www.iba-industrial.com/accelerators
[4] https://www.iba-radiopharmasolutions.com/sites/default/files/290319_iba_industrial-northstar-en.pdf

Kentaro Harada, Associate Professor, Group 1 (Beam dynamics & Magnets), Division 6 (Light Source), Accelerator Laboratory, High Energy Accelerator Organization. kentaro.harada@kek.jp