Feasibility of bromine-76 medical radionuclide production by $^7$Li$^+$ heavy ion

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Abstract
Bromine-76 (half-life = 16.2 hours) is a positron emitter radionuclide which has a high potential for use in nuclear medicine; but due to the difficulty of producing commercial quantities, it is only used in laboratory studies. This radionuclide is usually produced through the reaction of $^{76}$Se(p,n)$^{76}$Br. The purpose of this research is to investigate the possibility of $^{76}$Br commercial production by bombarding targets made of stable germanium isotopes with $^7$Li$^+$ heavy ion. The excitation functions of $^{70}$Ge(Li+$n$)$^{70}$Br, $^{72}$Ge(Li$^+$,$n$)72$Br, $^{73}$Ge(Li$^+$,$n$)73$Br, $^{74}$Ge(Li$^+$,$n$)74$Br and $^{76}$Ge(Li$^+$,$n$)76$Br reactions were drawn using the EMPIRE and LISEcute++ codes, and from the comparison of these excitation functions, the $^{72}$Ge(Li$^+$,$n$)72$Br reaction in the energy range of 30 to 40MeV was selected as the premier reaction. The maximum theoretical production yield in the energy of 40MeV for these codes are 32.46MBq/µAh and 61.43MBq/µAh, respectively. The theoretical and experimental yields of the $^{76}$Se(p,n)$^{76}$Br at energy 16MeV are 506.61MBq/µAh and 88MBq/µAh, respectively. From the comparison of the theoretical production yield of $^{72}$Ge(Li$^+$,$n$)72$Br and $^{76}$Se(p,n)$^{76}$Br reactions, it can be concluded that the $^{72}$Ge(Li$^+$,$n$)72$Br reaction is considered only when the target of $^{72}$Ge or a combination of that have long-term irradiation capability (without melting) and thus produce more $^{76}$Br activity in practice.

Keywords: Bromine-76, Germanium, Selenium-76, Monte Carlo simulation, Production yield