

3 - 28 Preparation of the Medical Isotope $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ by $^{100}\text{Mo}(\gamma, n)$ Reaction on an Electron Accelerator at IMP*

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^{99}Mo is applied for assemble the $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ generator for producing $^{99\text{m}}\text{Tc}$ to be used for the diagnosis of tumor or cancer. All over the world, 80% of radiopharmaceuticals used for diagnostic imaging were prepared with $^{99\text{m}}\text{Tc}$, which is the most used radionuclide in nuclear medicine. The Organization for Economic Co-operation and Development (OCED) Nuclear Energy Agency (NEA) forecasted that the requirement of $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ would increase up to 880 thousand Ci in 2030. Currently, most of ^{99}Mo is mainly produced by $^{235}\text{U}(\text{n},\text{f})$ reaction in nuclear reactor. However, this production route of ^{99}Mo using HEU (high enriched uranium) or LEU (low enriched uranium) is unfriendly with respect to the cost, safety and environment. Moreover, the aging nuclear reactors used for production of ^{99}Mo such as the National Research Universal (NRU) Reactor in Canada, SAFRI-I in South-Africa and the research reactor (b) BR-2 in Mol, Belgium are subject to unscheduled shutdowns and longer maintenance, which would create a ^{99}Mo shortage. To ensure a reliable supply of ^{99}Mo , the investigation on the alternative production route of $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ is of great importance.

In this work, ^{99}Mo were prepared by irradiation of enriched $^{100}\text{Mo}(> 98\%)$ with 40~50 MeV and 0.45 μA electron beam provided by an electron accelerator at IMP for about 5 days. After irradiation the ^{100}Mo target was dissolved with hydrogen peroxide and sodium hydroxide. Figure 1(top) shows that the γ spectrometry of stock solution. It is clear that the γ energy peaks of other nuclides were hardly observed, indicating that the purity of ^{99}Mo prepared by $^{100}\text{Mo}(\gamma, n)$ reaction was favorable. The stock solution was loaded in a 10 mL column filled with hierarchically macro/mesoporous $\gamma\text{-Al}_2\text{O}_3$ (HMMA) of about 2 g to assemble LSA $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ generator. After that, the generator was evaluated for about one week. $^{99\text{m}}\text{Tc}$ with high purity (see Fig. 1(bottom)) were collected in recovery of about 85%. Moreover, ^{100}Mo could be eluted by using 1.0 mol/L⁻¹ ammonium hydroxide with recovery of > 95%. $(\text{NH}_4)_2\text{MoO}_4$ could be attained by heating the ^{100}Mo solution. Finally, $(\text{NH}_4)_2\text{MoO}_4$ was in situ calcined at 600 °C for 2 h in a high-temperature tubular furnace under a flowing air condition. After that, the sample was calcined at 1 000 °C for 3 h with a flowing 4% H_2 -Ar. Finally, the ^{100}Mo powders were obtained with a recovery of about > 75%.

In a word, the preparation of the medical isotope $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ by $^{100}\text{Mo}(\gamma, n)$ reaction has a very broad application prospect. And meanwhile, it is a sufficient account that HMMA applied in assembly of the LSA $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ generator is feasible.

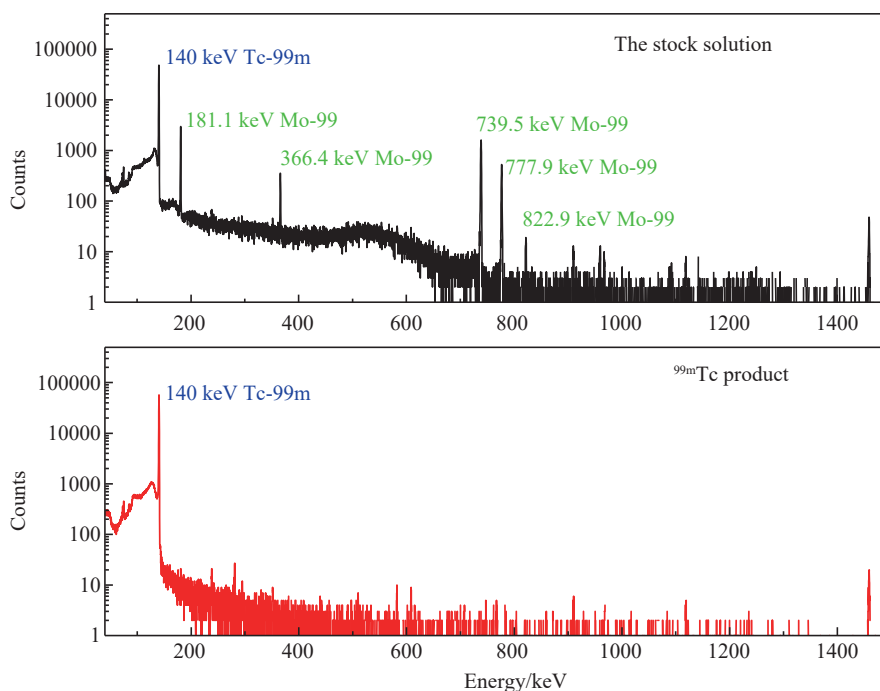


Fig. 1 (color online) The γ spectra of the stock solution and $^{99\text{m}}\text{Tc}$ product.