Preparation of Molybdenum Targets for High Current Cyclotron Production of Medical ^{99m}Tc Radionuclides

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INTRODUCTION

In this study we report a novel approach for the development of molybdenum targets to be used for high current cyclotron production of ^{99m}Tc radionuclide using the ^{100}Mo(p,2n) nuclear reaction. The challenge for the large-scale cyclotron production of ^{99m}Tc consists in the development of high-density 100Mo targets that are able to support multi-hour high current cyclotron irradiation, with high density, adhesion to baseplate, and high thickness, without material losses.

To obtain high-density molybdenum targets a pressing based method was developed. The features of the obtained molybdenum targets were established by Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) techniques. The prepared targets were also irradiated with protons at high-current cyclotron.

EXPERIMENTAL

Considering the high-price of isotopic 100Mo, all the research activities for developing the 100Mo cyclotron targets were performed by using a natural molybdenum (natMo) powder with the particle size almost similar with the measured one for the isotopic 100Mo powder. To evaluate the particle size of both the isotopic and natural molybdenum powders, SEM (Fig .1) and DLS analyses were performed and the results are displayed in Table 1.

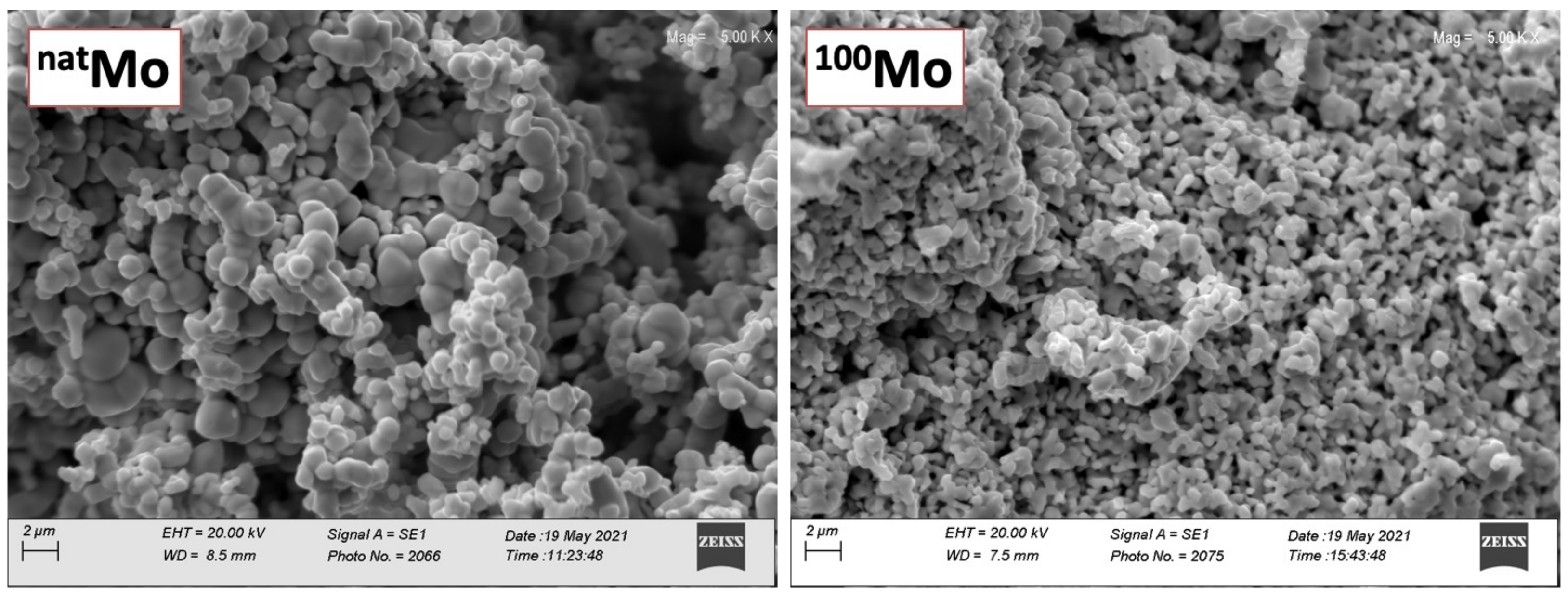


Fig. 1. SEM micrographs of ^{nat}**Mo** *and* ^{100}**Mo** *powders*

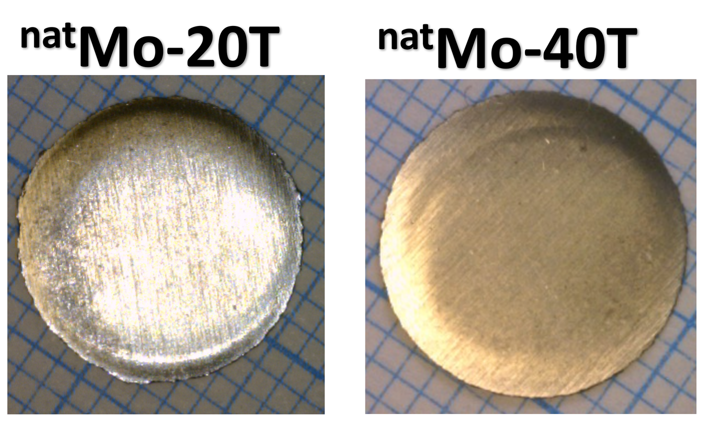
Table. 1*. Molybdenum powder characteristics*

Molybdenum type	Sample code	Purity (%)	Particle size (supplier)	Particle Size (SEM)	Particle Size (DLS)
Molybdenum-100 isotope, metal powder, 99.82% isotopic enrichment, Isoflex	^{100}Mo	-	-	~ 0.2 – 2 µm	0.92 µm
Molybdenum powder, Alfa Aesar	^{nat}Mo	99.95%	100 mesh	~ 0.2 – 3 µm	0.77 µm

Two types of target disks of 10 mm diameter and 300 µm thicknesses were prepared by pressing the ^{nat}Mo powder with the Automatic 40Ton Hydraulic Press by applying loads up to 40 tones (Table 2).

Table. 2 *The studied molybdenum targets*

Sample code	Applied load, tones
^{nat}Mo-20T	5+10+20
^{nat}Mo-40T	5+10+20+40



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RESULTS & DISCUSSION:

To evaluate the effect of the applied load on the properties of the obtained target disks' degree of compactness , SEM and AFM analyses were performed (Figs. 2 and 3).

Fig. 2*. SEM micrographs of molybdenum* targets

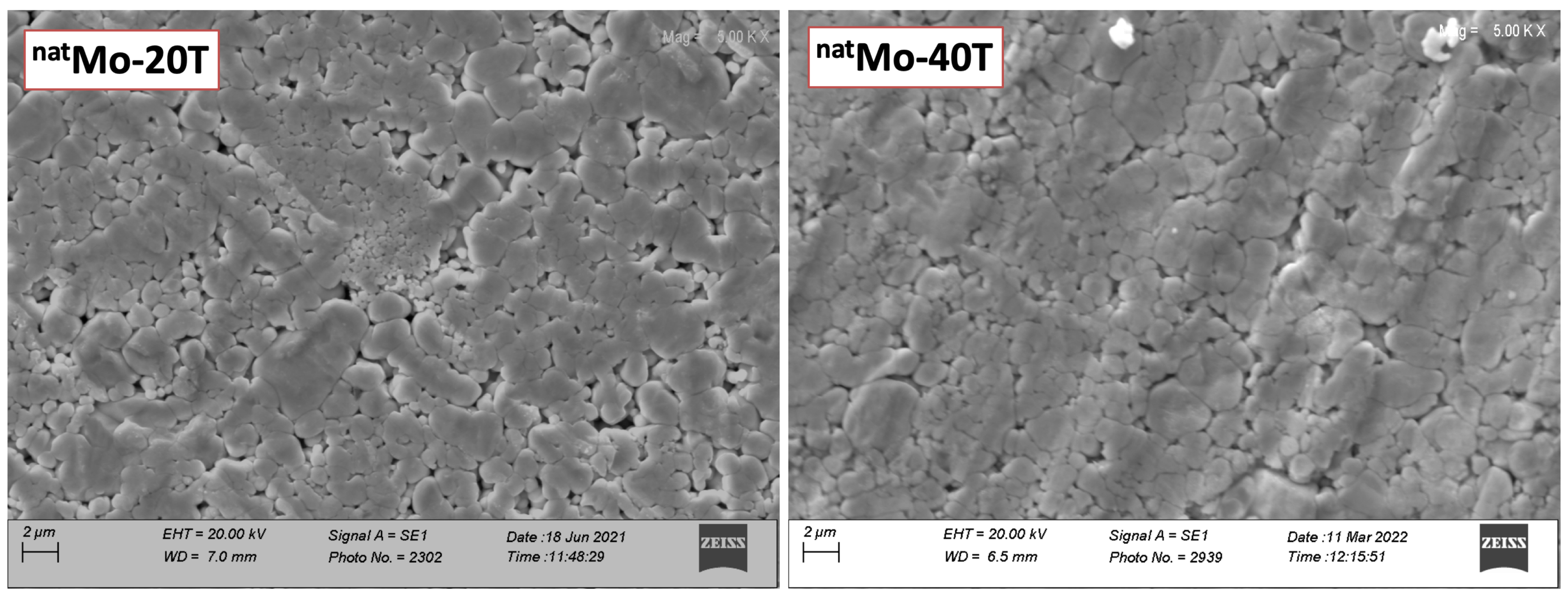
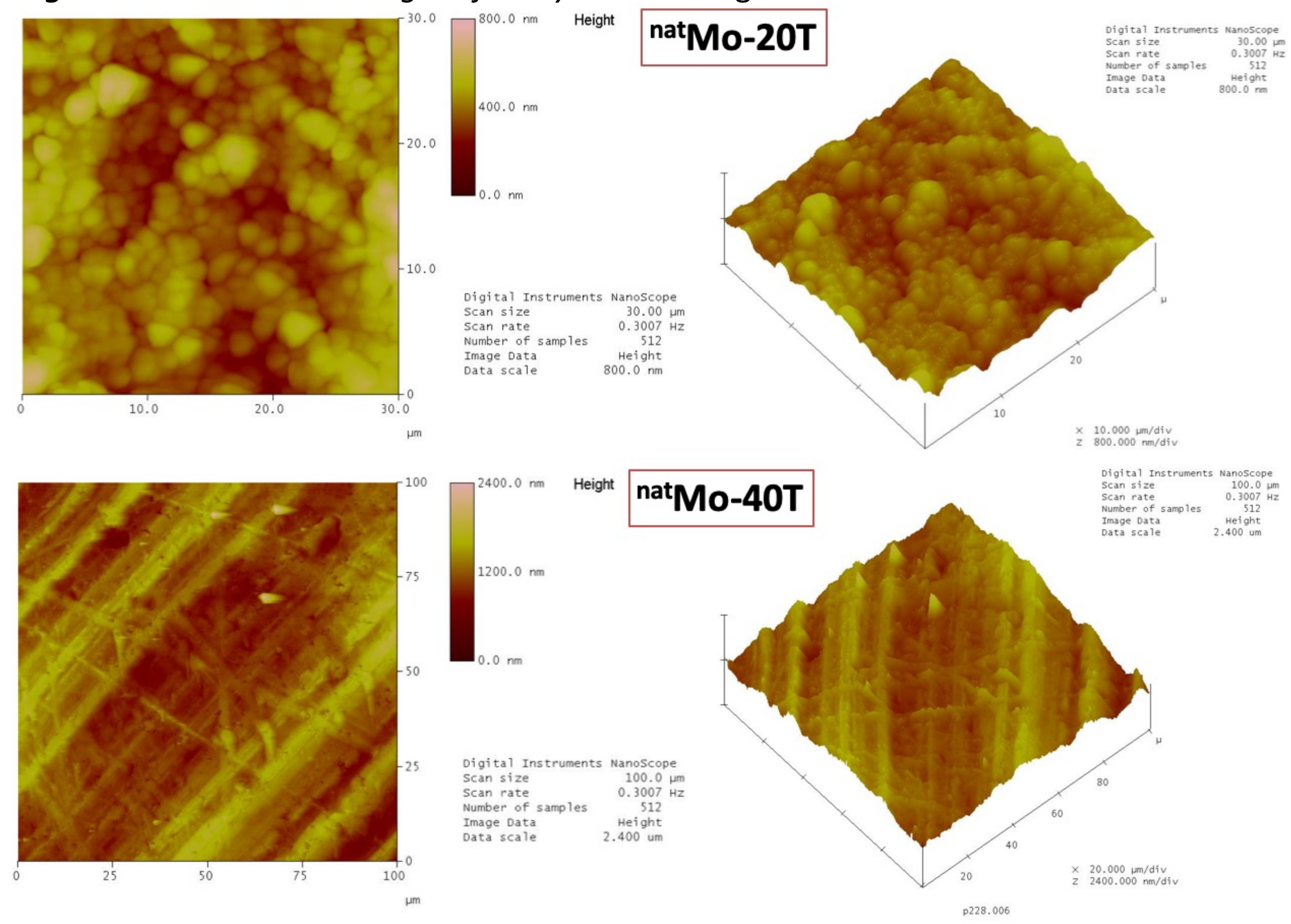


Fig. 3*. 2D and 3D AFM images of molybdenum* targets



This investigation's results show that the degree of compactness increases with the applied load from 20 tones to 40 tones. As evidenced by both SEM and AFM analyses, the highest compactness degree was achieved for **^{nat}Mo-40T target disk**.

Further, both **target disks** are tested by irradiation at IFIN-HH **TR19 Cyclotron for 1h at 50 µA**.

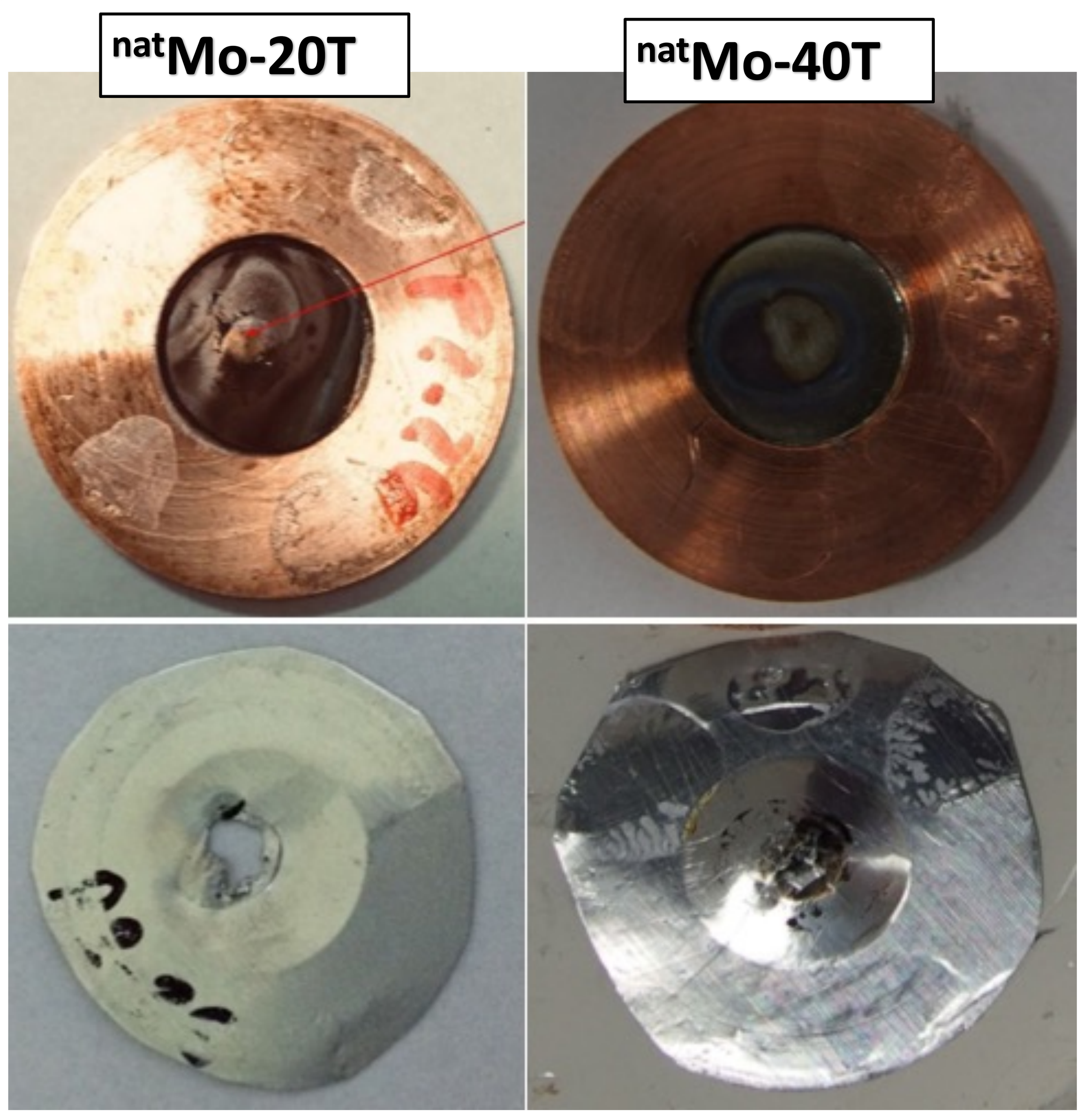


Fig. 4*. Molybdenum* targets after irradiation

The irradiation results, evidenced that the ^{nat}Mo-40T target is more stable during irradiation.