Installation and Preliminary Test of the Ion Accelerator for the Surface Analysis at KOMAC

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1. Introduction

An electrostatic tandem accelerator, which had been operating over 25 years at KIGAM (Korea Institute of Geoscience and Mineral Resources), is moved to KOMAC (Korea Multi-purpose Accelerator Complex) last year. For the purpose of supplying the qualified and quantified data from the irradiated species as part of the user service of KOMAC [1]. The accelerator is a pelletron with tandem type. The maximum voltage is 1.7 MV. The specification of the accelerator is shown in Table 1 [2].

Table 1: Specification

Manufacturer	NEC, USA
Model	5SDH-2
Maximum voltage	1.7 MV
Type	Tandem
Insulation	SF6 gas
HV charging method	Pelletron chain, 2 sets
Charging current	300 uA
Voltage ripple	< 500 V
H+ beam current	1.0 uA @ 0.5 MeV
H+ beam current	5.0 uA @ 3.4 MeV
He2+ beam current	2.0 uA @ 5.1 MeV

The accelerator has two ion sources which were SNICS (Source for Negative Ion by Cesium Sputtering) and a duoplasmatron. Also it has four beam lines, a PIXE (Particle Induced X-ray Emission) beam line, a RBS (Rutherford Backscattering Spectrometry) beam line, a beam line for ion implantation and for neutron production [3]. The layout of the accelerator installation at KOMAC is shown in the Fig. 1. In this paper, installation and preliminary test of the accelerator are reported.

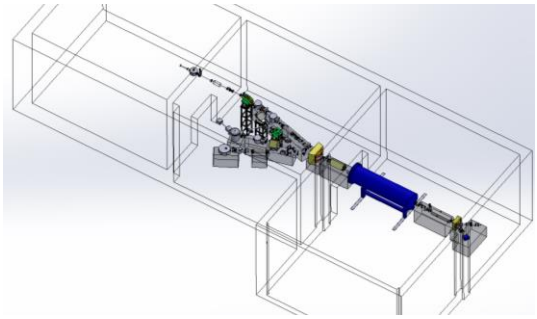

Fig. 1. Layout of the installation at KOMAC

2. Installation

2.1 Transportation

A pelletron has been moved carefully during the transportation using the vibration-free vehicle. The Figure 2 shows the vibration measurement during the transport of pelletron. The vibration was less than 100dB in condition of the below 80km/h of maximum speed of vehicle. As well as transferred to a minimum of vibration in the movement into the building.

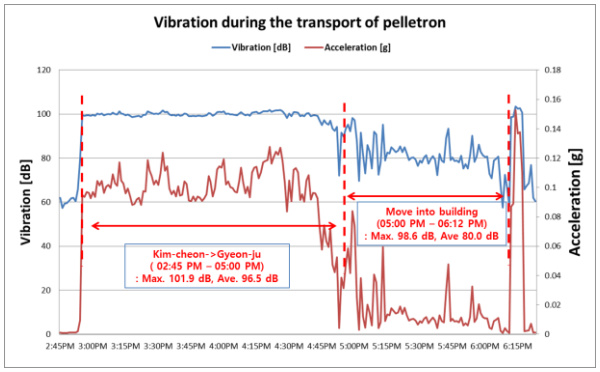

Fig. 2. Vibration measurement during the transport of pelletron

2.2 Alignment

The alignment for the accelerator components was done by using the theodolite which is a surveying instrument with a rotating telescope. And, electromagnets including the triplet-magnet, two doublet magnets and two bending magnets are aligned by using the laser tracker. The alignment of components of RBS beam line is shown in the Fig. 3.

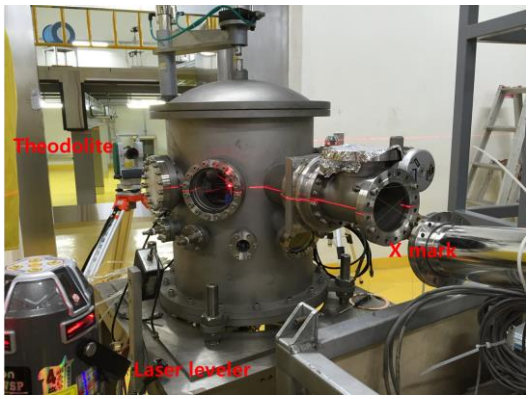

Fig. 3. Alignment of RBS beam line using the theodolite

2.3 Bending Magnet

In contrast to the neutron beam line of KIGAM, KOMAC uses two bending magnet to send a beam to the target. So, a new bending magnet has been fabricated and added with the same specifications. The magnetic field of a fabricated new bending magnet is shown in Fig. 4.

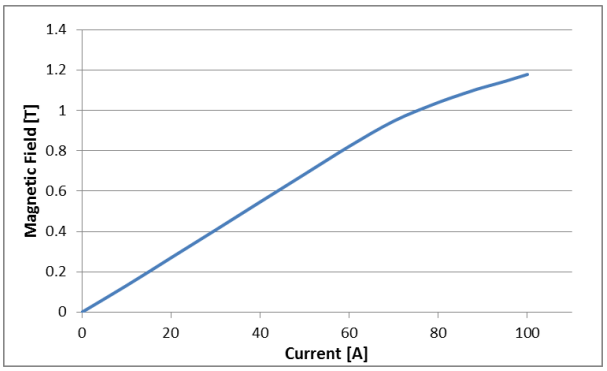

Fig. 4. Magnetic field profile of new bending magnet

2.4 Additional events (SF6, stripper gas, vacuum seal)

The 5SDH-2 is housed in a specially built pressure vessel that is to contain the SF6 (Sulphur hexafluoride) insulating gas required for high voltage operation. Its operation pressure is 75 psi and filled using by the treatment system. And the 5SDH-2 terminal is provided with a gas stripping system that converts incident negative ions into positive ions. This is accomplished by passing the beam through a nitrogen gas target resulting in charge collisions. The nitrogen gas is adjusted about 125 psi. In vacuum, there are special vacuum seals between the flanges of each of the vacuum components which were made of aluminum wire. The aluminum gasket fabrication of Al gasket is followed by NEC instruction. In related to vacuum, the roughing pump is changed from oil sealed rotary pump to dry scroll pump. Overall, Fig. 6 shows the installed 5SDH-2 including the utilities.

Fig. 6. Installed accelerator at KOMAC

3. Test

3.1 Vacuum

When the vacuum test after installation, two turbo-molecular pumps were failed and exchanged to new one. And then, vacuum tendency is shown in Fig. 6.

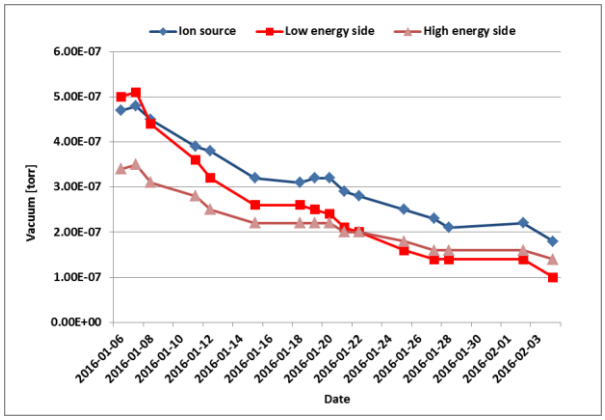

Fig. 6. Vacuum in the accelerator

3.2 High Voltage Conditioning

Once the vacuum system is prepared, it is necessary to conditioning process of accelerator. During high voltage conditioning, the accelerating voltage was slowly brought up to its rated operating voltage of 1.7 MV. There were several trip of vacuum after arcing in high voltage conditioning process.

3.3 Beam Extraction

The beam extraction test of the accelerator was accomplished by following operation instruction manual with ion source and running the beam. The operating beam current is 1.24 uA of ion source, 1.0 uA of pelletron outlet, 0.64 uA of PIEX beam line. So, the beam transmission is about 81% in beam line inlet and about 51% in PIXE beam line.

4. Conclusions

The ion accelerator for surface analysis was moved at KOMAC last year. The installation with alignment was done. The conditioning of high voltage was operated up to 1.7 MV. The beam transmission to PIXE beam line was achieved as 51%. The operation of the system starts in this year after it gets operation license from Nuclear Safety and Security Commission.

REFERENCES

[1] H. J. Kwon, et al., Installation Accelerator for the Surface Analysis, Transactions of the Korean Nuclear Society Autumn Meeting Gyeongju, Korea, October 29-30, 2015
[2] Operation manual of the Pelletron (5SDH-2), NEC, 1987.
[3] H. J. Woo, et al., Development of Ion Beam Nano Structure Techniques in KIGAM, Journal of Korean Physical Society, Vol. 52, No. 93, p743~751, 2008.