Positive Nickel Ion Beam Extraction with Bernas Ion Source at KOMAC

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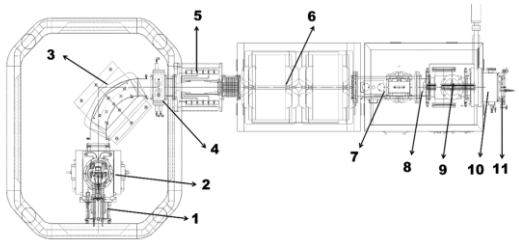
1. Introduction

Korea Multipurpose Accelerator Complex (KOMAC) provides metal ion beam irradiation service. The various positive metal ions beam such as Mn, Cu, Fe, Cr, Co, Mg, and Ti irradiate to target for surface modification. The bernas ion source can be extract various metal ion beams to heat the metallic chloride powder which has lower melting point than pure metal powder. The nickel ion beam extraction was performed to research of the magnetization of 2D materials and electromagnetic wave shielding.

2. Metal ion beam Facility of KOMAC

The metal ion beam consist of the bernas ion source, mass separation magnet, acceleration tube, magnetic quadrupole doublet, electrostatic raster scanner and target chamber as shown in figure 1 [1]. The bernas ion source has alumina crucible for vaporize the metal chloride powder up to 700 degree C. The vaporized metal gas was discharged to ionization about 100 V in arc chamber. The metal ions was extracted about 10 kV into mass separation magnet. The mass separation magnet was used for transferring the desire ions and charge state to target. The acceleration tube was accelerated the extracted ions up to 150 kV. A magnetic field was applied to MQD for focusing the beam on the scanner. To uniformly irradiate the focused beam to the target, the raster scanner sweeps the beam to 65 Hz in the X-axis and 517 Hz in the Y-axis through the two electrostatic plates. The target chamber consist of 4th faraday cup with digital current integrators. Target dose was precisely controlled with these digital current integrators [2].



1. Bernas ion source, 2. Ion source chamber, 3. Mass analyzer magnet, 4. Slit, 5. Acceleration tube
6. Magnetic quadrupole magnet, 7. Electrostatic X-Y scanner, 8. Beam profile monitor, 9. Beam stopper,
10. Target chamber, 11. In-situ Faraday cup

Figure 1. Schematics of the metal ion beam in KOMAC

3. Ni+ ion beam extraction

A metallic chloride vaporizer temperature depends on the vapor pressure, which is important parameter for extracting a metal ion beam. Too high vaporization causes internal contamination and electrical breakdown in insulation. The vaporization pressure temperature for Nickel Chloride ($NiCl_2$) is < 534 degree C at 0.0075 torr [3]. As shown fig. 2, the nickel vapor outgassing was started at 450 degree C.

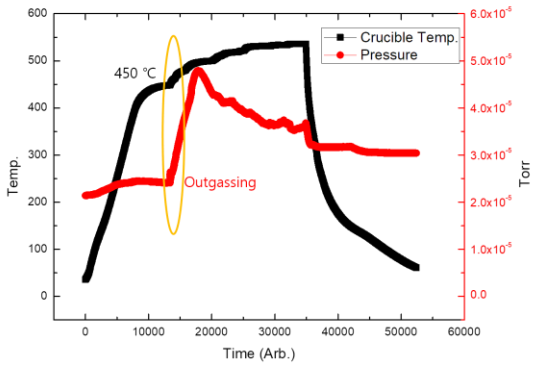


Figure 2. Vaporization pressure and crucible temperature condition for Ni^+ beam extraction

4. Certification Ni^+ ion implantation by using RBS.

The Ni+ ion beam was irradiated to Si wafer sample to confirm that implantation of Ni ion by using Rutherford Back Scattering analysis method in KIST (Korea Institute Science and Technology). The sample was irradiated by 140 keV energy with a fluence 1E16 ions/cm^2. As shown fig. 3, the counts of Ni ions were 1.17 × 1016 ions/cm2 in the RBS spectra. The energy channel shows the energy of back scattered alpha particles by Ni ion.

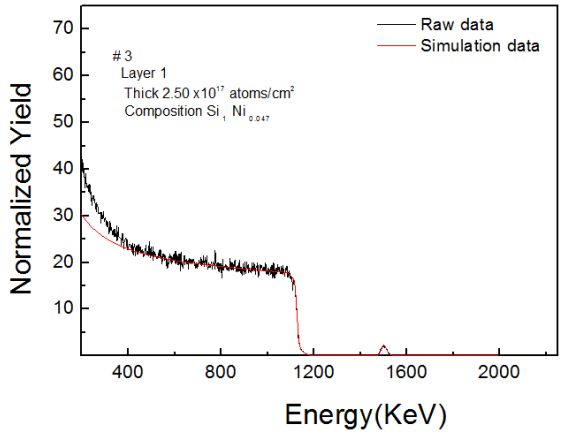


Figure 3. RBS analysis results by Ni^{+} ion beam implantation

5. CONCLUSION

The KOMAC has been operating the metal ion beam instrument to provide metal ions as a Cu, Co, Fe, Cr, Mg, Mn, and Ti for various applications. The Ni+ ion was successfully obtained by vaporizing NiCl(II) powders. Also optimal vapor pressure and temperature condition was set to extract Ni+ ion beam stably. Ni ion implantation was quantitatively verified by using the RBS analysis method. Hence, we ensured that Ni ion beam can be provided with good uniformity and an accurate dose rate.

REFERENCES

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