§6. Development of Ion Source for Thin Film Formation

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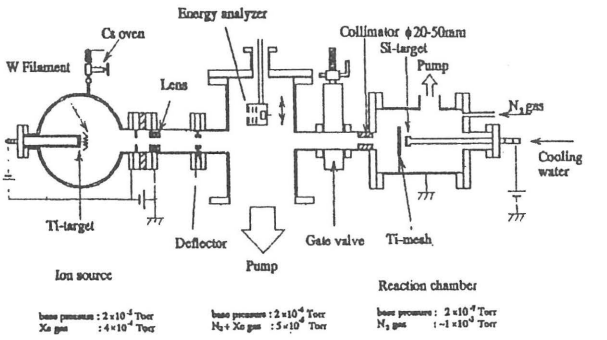
We have developed a plasma-sputter-type negative ion source which is not only useful as an ion source of tandem-type heavy ion beam probe for the Large Helical Device but also for ion beam application such as ion implantation or thin film formation. In the present study, a one liter volume ion source to study Au^- is used by changing the gold target to a titanium target. The experimental setup is shown in Fig. 1. The produced Ti^- beam is collimated into a reaction chamber with nitrogen gas. The resulting interaction of the ion beam and nitrogen on silicon substrate in investigated. The use of a plasma-sputter-type negative ion source presents a new approach for the production of high grade coatings like TiN.

The ion source was operated at typical base pressure of 1.8 x 10-6 Torr. A xenon arc plasma was produced at 2.0 x 10-4 Torr. Typical operating parameters for the discharge are: discharge current = 4mA, Discharge voltage = 30 V, filament current 12 A, and target potential = -300 V. The ion beam has a typical energy width of 9eV with a characteristic negative ion current of several tens of nanoamperes. In this development, the beam characteristics of Ti^- as functions of operating conditions like the discharge voltage, discharge current, beam acceleration voltage, lens voltage and target voltage were examined as shown in Fig. 2-4. Because of the low electron affinity of titanium, the Ti^- yield should be expected to be very low. In order to obtain a significant amount of beam flux onto a target chamber, added features like a beam deflector and a lens system have been developed and incorporated in the experimental setup. By property operating the lens system, a higher Ti^- current at the reaction chamber and an increase of the probability of interaction on the subtrate surface. This means a shorter time for film deposition in the reaction chamber.



Schematic view of experimental set up

Fig.1

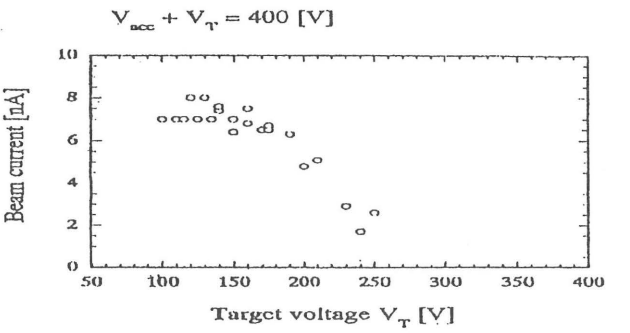


Fig. 2

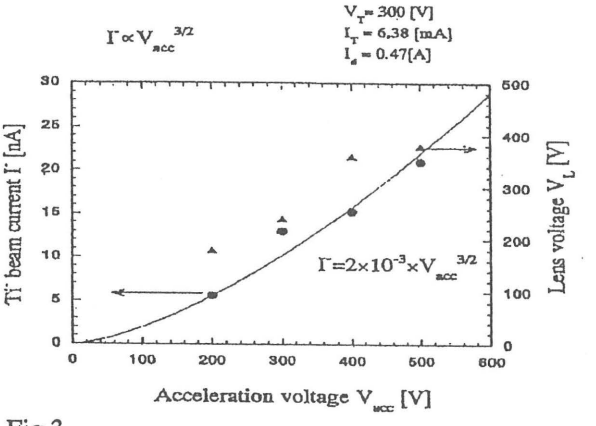


Fig.3

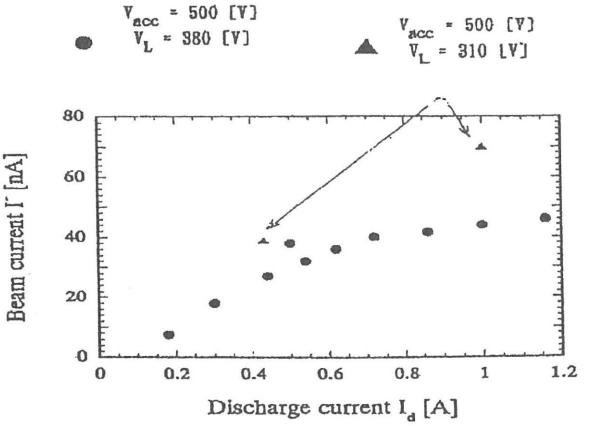


Fig.4

I_d = 0.44 [A] -> Ic = 6.0 [mA]