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NASA TECH BRIEF

Langley Research Center

Calorimetric Detection of Neutral-Atom Content of Ion Beam

The accurate determination of an ion-beam dose is important in the production of ion-implanted semiconductor devices. The neutral atoms in the beam can lead to inaccurate doping and localized sputtering of the semiconductor target. A method has been established to determine the neutral-atom-beam flux, dose, or power density. An energy deposition technique was used to deduce the neutral-beam flux or dose from the measured values of incremental resistance increases in a platinum wire passed through the beam. A steady-state heat balance analysis led to the equivalent neutral-beam current.

The method was used to detect the neutral-atom content of a 60-keV argon ion beam. A conventional plasma source was used to generate ionized argon; the cathode was tungsten. Extracted ions were formed into a beam via an electrostatic lens system and then were magnetically analyzed to produce a singly-ionized argon beam in the target region. Fast neutral production occurred between the analyzing magnetic and the vertical deflection plates (a distance of about 75 cm) where the pressure was less than 10^{-5} torr. The target chamber was offset upward so that deflecting the ion beam upward to focus it on the beam stop separated the neutral beam which continued straight (see Figure 1).

A probe was designed for the calorimetric detection of the neutral atoms; it was made from a small-diameter platinum wire (see Figure 2). The wire detector was swept through the neutral beam perpendicularly to the particle path. Several data points were obtained, since

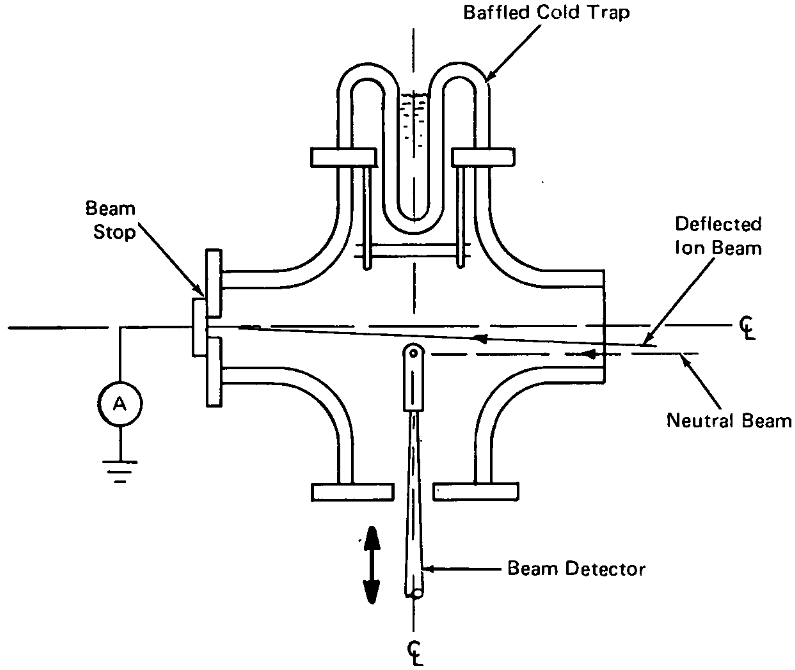

Figure 1. Target Chamber

(continued overleaf)

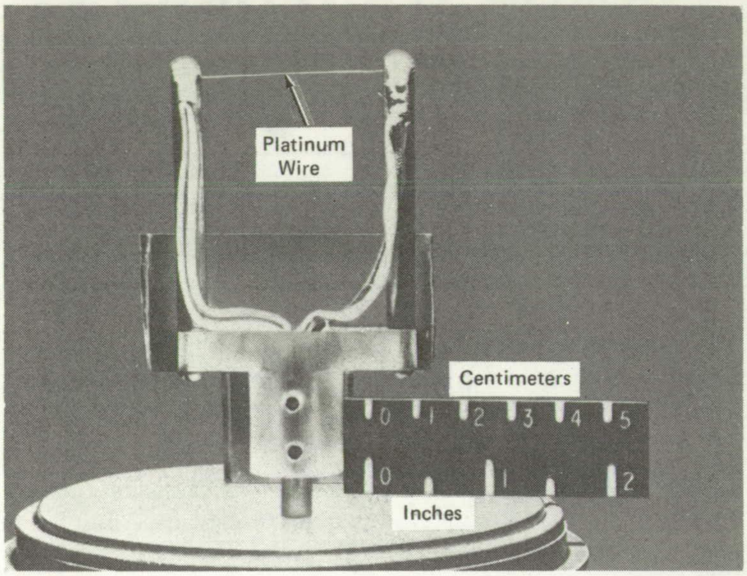

Figure 2. Wire Detector Assembly

the beam diameter was 7 to 10 mm. The neutral-beam dose could be computed if it were assumed: (1) that the neutral-atom energy was the same as the ion beam and (2) that the wire completely absorbed the kinetic energy of atoms striking it.

A calorimetric method was used to convert incremental changes in the wire resistance to an average temperature rise. A steady-state heat balance was used to determine the local heat flux to the wire. The integration of a power density profile led to the equivalent neutral-beam current. This method enabled the detection of a neutral-beam current of about 1 percent of the ion-beam equivalent current.

Note:

Requests for further information may be directed to:

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Patent status:

NASA has decided not to apply for a patent.

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