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EXPERIENCE WITH A SADDLE FIELD ION SOURCE FOR SPUTTERING

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Abstract

A discussion is presented concerning the method of setting up a saddle field ion source for sputtering thin films. Preliminary results will be presented for sputtering rates of different materials.

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The theory and principles of the operation of a saddle field source have been previously described by both Franks[1] and by Drinkwater.[2] Some of the unique properties of this source[3] may make it quite useful for producing particular types of thin films. Some of these include:

1. Beams contain a high percentage of energy neutrals. Therefore one can sputter insulating, as well as electrically conducting materials.

2. The source produces a beam of about 2 mm diameter, allowing one to use small amounts of separated rare isotopes.

3. The source uses a cold filament which produces a temperature rise of the evaporant of only ~ 10° C, insuring no damage to substrate or release agent from heat. The substrate can be placed very close to the source, thus insuring a high efficiency for sputtering.

4. There is no magnetic field, only an electrostatic one.

The schematic drawing of Fig. 1 shows the general principles of operation of the sputter source. Electrons oscillate between the two cathodes through a central anode under the influence of the dc field. Argon introduced into the source is readily ionized, positive ions produced are attracted to the cathodes, and the emerging beam contains a percentage of neutrals which depends on the distance of the sputter gun from the material being evaporated.

This paper presents several set-up and sputter procedures which we have found quite useful toward the successful operation of this saddle field ion source. It is very important that all components of the gun are carefully aligned so that the Argon beam will pass accurately through the center of the gun as misalignment usually shorts out the source, making it totally inoperable. A tool is available for this aligning procedure.

The source arrangement for sputtering a target is shown in Fig. 2. For best results it is important that the gun be at a thirty degree angle to the horizontal surface and about 5 cm from the sputter source. These parameters result in a high efficiency of sputter source use and minimize the amount of material deposited inside the gun. In addition, at larger angles, the large amount of material sputtered back into the source will make frequent and often difficult cleaning necessary. Materials such as silicon may have to be removed using tools in the machine shop.

The following set-up procedures are useful when sputtering target material:

1. Use a vacuum - $\sim 10^{-5}$ Torr.

2. High purity Argon is a necessity. Use a very low flow rate. There is only a slight effect on the quality of the vacuum from the argon introduced into the system; typically it may be reduced about 0.2×10^{-5} Torr.

3. Normally, for good sputter rates, use about 2 ma. current at 6 keV with an ion current of about 5 ma. These values can be adjusted to maximum rate by fine tuning argon flow rate.

4. A good needle valve is needed to accurately adjust the flow rate.

5. There must be no leaks in the argon supply line as this will prevent the source from operating properly.

6. The source must be aligned accurately. This is critical.

7. The beam can be seen in the dark. This allows the careful alignment of the gun, particularly when using a very small amount of sputter material.

8. Purchase of high voltage, argon and water feed-thru's with the gun and power supply may be good economy.

TABLE I. Preliminary sputter rates for different materials.

Element	Glover[4] (μg/cm^2/hr)	Drinkwater[2] (μg/cm^2/hr)	Ours (μg/cm^2/hr)
Ag	22	26.3	
Au	44	40	44
Co	12		
Fe	10	3.9	
Mn		8.6	
Ni	13	5.3	
Os		8.0	
Pb		25.2	
Pt	45		
Si			4
Sn	14	14.6	
W		12.5	
Zn	10		

It can be readily seen that the sputter rates are very low. However, it takes about one half hour to stabilize the system for sputtering a target but after this is completed it can be left virtually unattended overnight and usually for several days with only slight adjustments.

In conclusion, this type sputter source has the advantage of producing a cold deposition with no damage to the substrate, the release agent, or the deposited material. In addition, it produces good adherent deposits and with the proper sputter parameters a small degree of implantation may be obtained. Further, it may be used for ion milling. Although the system has a high efficiency for evaporation it has a low sputter rate with a limited target size. This type gun may be quite useful particularly for sputtering relatively small amounts of material for special applications.

Footnotes and References

[*] This research was supported by the U. S. Department of Energy under Contract W-31-109-Eng-38.

1. J. Franks, International Journal of Mass Spectrometry and Ion Physics, 45 (1983) 343-346.

2. R. J. Drinkwater, Proc. 11th World Conf. Intl. Nuclear Target Development Society (1982), ed. G. M. Hinn, held at Seattle, WA, Oct. 6-8, 1982 (University of Washington, Nuclear Physics Laboratory).

3. Saddle Field FAB11NW source and B50 power supply produced by Ion Tech LTD., 2 Park Street, Teddington, Middlesex TW11OLD, England and purchased from VCR Group, 68 Meadowbrook Drive, San Francisco, CA 94132. Our thanks to Vincent Carlino at the VCR Group for several useful consultations in setting up the system.

4. Kate Glover, AERE Harwell, Oxfordshire, OX11ORA, United Kingdom, supplied these preliminary results by private communication.

Figure Captions

Figure 1. Schematic drawing showing the general principles of operation of a saddle field sputter source.

Figure 2. Schematic drawing of a typical arrangement for producing a sputtered target.

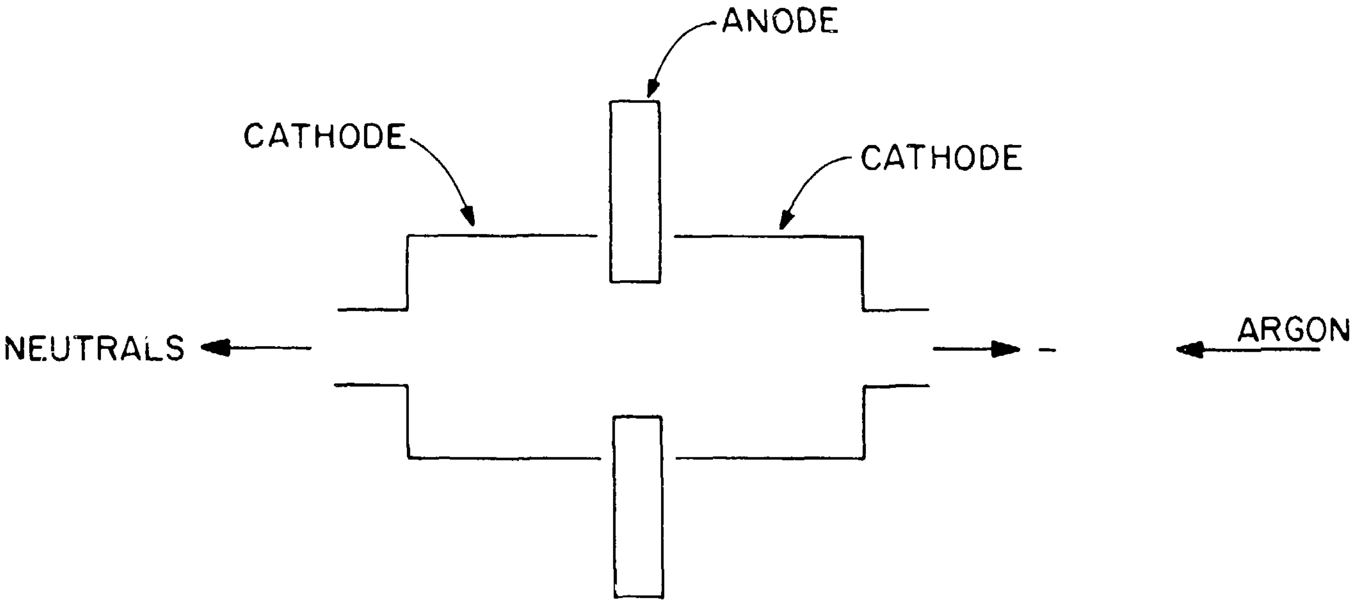

Fig. 1

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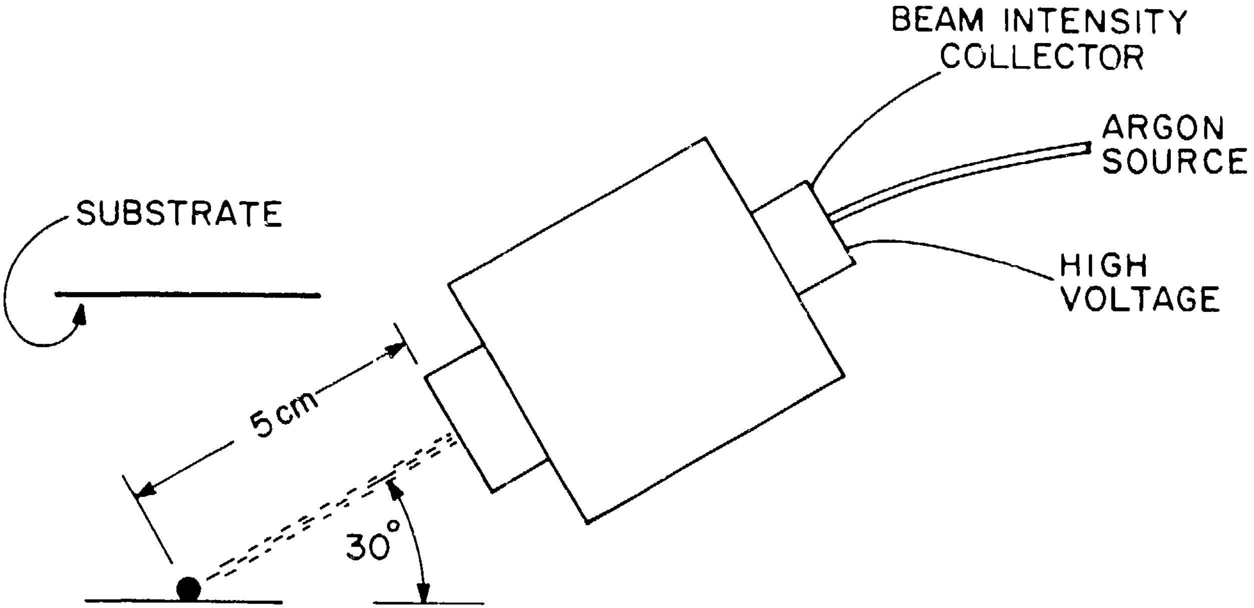

Fig. 2