Preparation of thin Gold foil via rolling method

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Introduction

In nuclear physics experiments many times thin metal foils (thickness ~ 1 mg/cm^2 or less) are needed, either to be used directly as a target (as self-supporting foil) or as a backing to the real targets. If the material is malleable like Au, Ag, Al, Ta, Tb, Ho, etc. then historically the best method to obtaining such foil is via rolling method. In this method the least thickness obtained depends upon malleability of the material and its density. For low density materials like Al, Fe, Ni, etc. the thickness ~ 1 mg/cm^2 are easily achievable, however for the high density materials like Ta, Au and Pb, it is extremely difficult to come down to such low values and thicknesses of ~ 4 mg/cm^2 can be achieved at the best. To prepare thinner foils than this value for high density materials, some extraordinary efforts with improved techniques are required. In the present work we report the making of a thin foil of natural gold (~ 1.7 mg/cm^2) made via rolling method. The prepared thin gold foil is expected to be used as a backing foil to the ^{76}Ge target for an approved recoil distance Doppler shift (RDDS) method [**1**] lifetime measurement experiment at Inter University Accelerator Center (IUAC), New Delhi. Using gold as backing material on target made by evaporation method in RDM experiments is highly advantageous as it is stable, has good thermal conductivity, mechanical strength, easy to stretch, high melting and boiling points and also has a shiny surface.

Principles of Rolling technique

Mechanical rolling is one of the most systematic and cost-effective method for the preparation of thin foil of thickness ~ 0.5 - 10 mg/cm^2. The minimum thickness obtained by rolling method depends on the physical and chemical properties of the target material to be rolled. A picture of rolling machine at IUAC is shown in Fig. 1. In this technique the material to be rolled is placed between a bended mirror polished stainless steel (SS) plate (Fig. 2(a)). The plate is then fed into the hard rollers of the rolling machine. The procedure of rolling of different type of material is vary according to their mechanical properties, density, chemical reactivity etc.

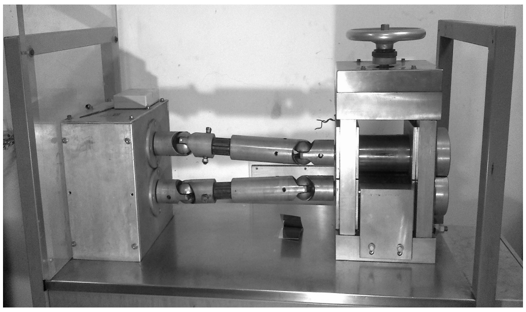

Fig. 1: A picture of rolling machine at IUAC.

Cold Rolling of Gold

The available gold material in the target lab of IUAC was in the form of thick metal foil. Initially a thick gold foil of thickness ~ 100 mg/cm^2 was placed inside the folded SS sheet. The SS sheet with gold foil was then inserted into the hard cylindrical rolls of the rolling machine. The SS sheet became slacked after applying the pressure which resulted unwanted strain in the foil. To avoid the slackness in the SS sheet, it was once heated up to 1500^0 C before

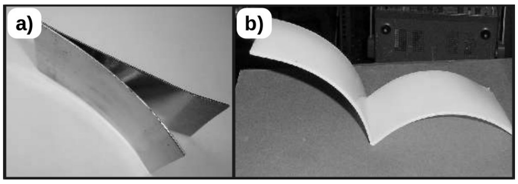

Fig. 2 : A picture of a) folded pack of Teflon sheet and b) bended steel sheet.

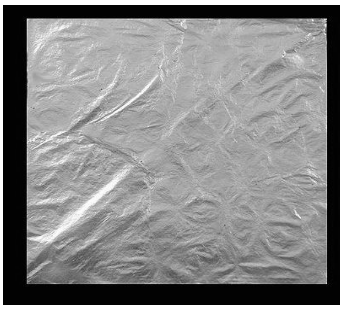

Fig. 3 : A picture of a gold foil made by rolling method at IUAC.

start rolling. Another issue with the Au foils was to start sticking with the SS sheets when the thickness was reached to ~ 6 mg/cm^2. To avoid the sticking and for the further reduction of thickness of Au foil, the Au foil was carefully shifted into a folder of 6 cm wide and 8 cm long folded pack of Teflon (Polytetrafluroethele-ne) sheet (Fig. 2(b)) but the foil has broken after applying the pressure. Application of silicon oil on foil was also not successful as foil was sticked in SS sheet. Finally, a successful attempt was done by using alcohol drops inside the folded SS sheet and it gave remarkable results. As the density of alcohol is very small (~ 0.789 g/cm^3 at room temperature), the sticked gold foil was floated on SS sheet just after putting some alcohol drops on it. It was observed that the use of alcohol drops can also prevent the sticking of gold foil at the time of rolling. At the lower thicknesses, the cracking was seen at the borders, those sides were trimmed immediately in order to stop the further cracking. In this way it was possible to achieve the thickness of gold foils ~ 1 mg/cm^2. Clean surface of foil and additional care in rolling are most important to avoid the tiny holes and wrinkles in the target foil. The foil was dipped in acetone to remove dust particles and other impurities. The area of the rolled foil was measured by using a graph paper with a precision of 1 mm^2 and the weight of the foil was measured by using a micro-balance with a precision of 0.1 mg. Lastly, a highly clean, smooth and uniform gold foils of thicknesses ~ 1.7 mg/cm^2 were successfully prepared by rolling method at the target lab of IUAC. A picture of gold foil of thickness 1.7 mg/cm^2 is shown in Fig. 3.

Conclusion

A clean, smooth, uniform and thin gold foils have been successfully prepared by using the rolling machine at IUAC, New Delhi. Alcohol drops are used to avoid the sticking of thin foils during rolling. These foils are going to be used as a backing for the fabrication of ^{76}Ge target by using an electron gun evaporation technique at IUAC, New Delhi.

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References

[1] T. K. Alexander, et al., Advances in Nucl. Phys., edited by M. Baranger and E. Vogt (Plenum, New York, 1978), Vol. 10, p.197.