UNCLASSIFIED

AECD-4050

UNITED STATES ATOMIC ENERGY COMMISSION

THE PREPARATION OF URANIUM FOIL

By

H. A. Saller
J. R. Keeler

October 1, 1948

Date Declassified: November 22, 1955

Battle Memorial Institution
Columbus, Ohio

Technical Information Service, Oak Ridge, Tennessee

UNCLASSIFIED

TABLE OF CONTENTS

	<u>Page</u>
SUMMARY.	4
INTRODUCTION	4
EXPERIMENTAL WORK.	5
Hot Rolling	5
Cold Rolling.	6
Annealing Studies	6
Hardness Studies.	7
Preparation of Special Samples.	11

This report was prepared as a scientific account of Government-sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately-owned rights. The Commission assumes no liability with respect to the use of, or from damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

SUMMARY

Uranium foil 0.001 inch thick was made by rolling cast specimens at 600°C. in a steel jacket and cold rolling the resulting 0.012-inch-thick strip to the desired thickness. The foil was of excellent quality, having no pin holes and only very slight edge cracking.

INTRODUCTION

In order to study the effect of radiation on the structure of uranium, Oak Ridge National Laboratory requested a supply of uranium foil approximately one mil thick. [REDACTED]

The method used, therefore, had to be one which entailed no loss of metal and which required only a small cast sample as starting material. Hot rolling in a steel jacket met both of these requirements. Very small samples could be rolled at 600°C. without oxidation to a thickness of 0.009 inch to 0.012 inch, and this strip could then be cold rolled to 0.001 inch without annealing.

This method of producing foil is similar to that developed independently and simultaneously at Argonne National Laboratory(1)

(1) Argonne National Laboratory Report Number ANL 4103.

EXPERIMENTAL WORK

Normal uranium, having the natural distribution of isotopes, was used in all of the preliminary work for developing a method of producing 0.001-inch sheet and for determining the properties of this foil.

Hot Rolling

Cast samples, $1/4$ inch x $1/2$ inch x $1/8$ inch, were jacketed in mild steel jackets 3 inches square. The sample was carefully fitted into a hole in a frame $1/8$ inch thick, and two covers 0.156 inch thick were placed on each side of this frame. The edges were then welded, completely enclosing the sample in a gas-tight steel jacket. Magnesium oxide was used to prevent the uranium sticking to the steel during rolling.

These assemblies were rolled at 600°C. in the Battelle experimental 6-inch x 12-inch mill. A reduction of 0.025 inch per pass was made, and the strip was reheated after each pass. By repeated passes with the rolls set tightly together, it was possible to roll the assemblies to 0.031 inch. The finished hot-rolled assemblies were returned to the furnace and soaked $1/2$ hour at 600°C. and air cooled.

The resulting uranium strip, after stripping off the steel jacket, was 0.009 inch to 0.012 inch thick. The surface was relatively smooth and colored slightly by oxidation. Pickling in concentrated nitric acid removed this thin oxide film and any MgO adhering to the surface.

Cold Rolling

After pickling, the strip was cold rolled in a power driven 2-inch x 3-inch jewelers mill. The rolls were set as tightly together as possible throughout the cold rolling, and kerosene was used as a lubricant.

The reduction per pass was very small, particularly after the strip reached a thickness of about 0.003 inch. The total number of passes required to produce 0.001-inch foil varied from 140 to 450, depending on the composition and annealing temperature.

Only slight edge cracking occurred in 90 per cent cold reduction, and the foil was flat and highly polished. The width of the strip increased from 3/4 inch to approximately one inch during the cold rolling, but no pin holes or other rolling defects developed.

It was possible to obtain foil thinner than 0.001 inch by the use of an intermediate anneal and continued cold rolling. A sample cold rolled from 0.012 inch to 0.003 inch and annealed 1/2 hour at 600°C. was reduced to 0.0005 inch by continued cold rolling. Pack rolling was tried in order to obtain foil less than 0.001 inch thick, but the strips tended to skew apart. No satisfactory method of holding the strips together was found.

Annealing Studies

The effect of gamma annealing on the rolling characteristics was investigated. Samples of hot-rolled strip 0.012 inch thick were cold

rolled to 0.005 inch and annealed 1/2 hour at 600°C. and at 800°C. in a vacuum. These samples were then cold rolled to 0.001-inch foil. Figure 1 shows the rate of reduction after annealing at each temperature.

The annealing temperature did not materially affect the rate of reduction from 0.005 inch to 0.0016 inch. The gamma-annealed strip, however, required three times as many passes to reduce the thickness from 0.0016 inch to 0.001 inch as did the alpha-annealed material.

The foil rolled from the gamma-annealed strip was not flat. A wrinkling or puckering developed during the cold rolling, probably as a result of the large grains developed by the gamma anneal. Figure 2 shows the appearance of the foil obtained from the strips annealed at each temperature.

Hardness Studies

Knoop hardness measurements at 100-gram load were made on the alpha-annealed uranium after various amounts of cold reduction. Figure 3 shows the relation of hardness and cold work, and indicates that hardness was nearly directly proportional to the reduction up to 75 per cent.

With greater amounts of reduction, the thickness of the sample approached the width of the impression made by the diamond, and the data were not considered reliable. Reducing the load on the diamond from 100 grams to 25 grams decreased the size of the impression, but the data were erratic.

FIGURE 1. EFFECT OF ANNEALING TEMPERATURE ON THE RATE OF COLD REDUCTION OF NORMAL URANIUM.

O-9512

800°C.

600°C.

56854

Figure 2. Appearance of 0.001-inch foil rolled from strip annealed at 600°C. and 800°C.

FIGURE 3. THE EFFECT OF COLD REDUCTION ON THE HARDNESS OF ANNEALED NORMAL URANIUM FOIL

Q-9513

Hardness measurements were also made on foil obtained from gamma-annealed strips, but the hardness numbers on each sample varied over a wide range. In general, the data indicated that the strip annealed at 800°C. was initially softer, but work hardened more rapidly than alpha-annealed material.