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MIT-2018

PROGRESS REPORT FOR JANUARY 1954

January 27, 1954

Metallurgical Project
Massachusetts Institute of Technology
Cambridge, Massachusetts

Technical Information Service, Oak Ridge, Tennessee

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M.I.T. METALLURGICAL PROJECT
A. R. Kaufmann, Director
T. T. Magel, Assistant to Director

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MIT-2018(P)
Progress Report

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M.I.T. METALLURGICAL PROJECT

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Progress (P) Report

for

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Massachusetts Institute of Technology
Cambridge, Massachusetts

Contract AT(30-1)-981

A. R. Kaufmann, Director
T. T. Magel, Assistant to Director 34

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A. Research

1. Beryllium Metallurgy

1.1 Beryllium Reduction and Purification

1.16 Analytical Methods: Routine analyses continue.

1.2 Beryllium Melting and Casting: No work.

1.3 Beryllium Fabrication

1.311-1 Extrusion of Jacketed Beryllium: Thirty-six small rods of beryllium were extruded.

1.311-4 Extrusion and Drawing of Beryllium Tubing: No work.

1.4 Physical Metallurgy of Beryllium

1.41-5A Tensile Properties of Sized and Extruded Beryllium Powders: Testing of the rolled-extruded stock continues and elongations of 30-40 percent in two directions continue to be observed.

Preliminary investigation by the Norton rod (x-ray) method showed no differences in the amount of [001] fibre texture in rods extruded to 28:1, 38:1, and 45:1. The amount of preferred orientation apparently changes little, if any, with reduction ratio in this range.

1.43-3 Annealing Behavior of Deformed Cast Beryllium: Work on this program has been held up because of work on the SRO problem.

2. Uranium Metallurgy

2.2-1 Extrusion Cladding of Uranium: An alloy of uranium with 0.5 wt.% zirconium appears to be more stable in thermal cycling than the 2% alloy. The study of the effect of cladding (Zr) on the thermal cycling behavior of uranium continues.

Uranium and zirconium billets are being machined for assembly into a composite billet for extrusion. The special shapes found so promising in eliminating the end effects with brass-copper extrusions are being tested with uranium clad with zirconium.

Some 1.6 at.% silicon in uranium alloy has been tested in the thermal cycling apparatus and appears rather stable—0.5% per 100 cycles.

2.8 Cooling of Uranium with Liquid Metals: Work on casting U-Cr eutectic around a 2" diameter bundle of bare Globe iron tubes, cooled internally with flowing Pb-Bi, is being discontinued. Either it was not possible to fill the cavity with eutectic or the latter alloyed excessively with the iron causing rupture of the tubes and intermixing of eutectic and coolant.

Templates are ready for assembling a 6" hexagonal section of tubes (1027 tubes), around which tubes U-Cr will be cast.

The heat transfer apparatus has been set up for a final run to test how long zirconium tubing will resist attack by U-Cr eutectic at some temperature slightly above 850°C.

Steel dies have been used successfully for "stamping" fine detailed slots and ridges into hot (just below the melting point) U-Cr eutectic.

2.10 Other Uranium Work: Dilatometric studies on U-Zr alloys continue. Work on U-Si (epsilon) temporarily suspended.

3. Thorium Metallurgy

No work.

4. Zirconium Metallurgy

4.1 Zirconium Reduction and Purification

4.17 Analytical Techniques: Work continues on a new method for determining Hf/Hf + Zr in amounts from 1 - 100%.

4.18 Preparation of Zirconium with Known Contaminants: Controlled additions of oxygen have been added to zirconium for the study of heat treatment versus corrosion resistance.

4.2 Melting of zirconium: No work.

4.3 Fabrication of Zirconium: No work.

4.4 Physical Metallurgy of Zirconium

4.45 Alloys of Zirconium with Uranium, Thorium, etc.: The determination of the solidus in the U-Zr system is continuing. Additional zirconium alloys between 75 and 96 wt.% uranium are being studied dilatometrically.

5. Corrosion Studies

5.1 Pure and Contaminated Zirconium in 600°F water: Nothing new to report.

5.10 Corrosion in 750°F Steam: Data is being accumulated to show the relative effects of temperature and pressure in steam corrosion testing.

5.12 Corrosion at Other Temperatures: 680°F water. Interesting data is being obtained on the effect of annealing previously quenched (from between 800°-900°C) zirconium and Zircaloy II. The effects of small additions of iron and nickel on corrosion resistance of quenched zirconium are being observed. Nickel appears more effective than iron in preventing corrosion in this series of experiments.

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5.5 Corrosion Properties of Aluminum-15% Uranium Alloys: After 28 days in boiling water, extruded aluminum specimens with imbedded graphite particles showed no pitting corrosion. Extruded aluminum with no apparent imbedded graphite particles and as-received aluminum showed about the same corrosion: wt. gain after 28 day, 13 mg/dm^2.

6. Aluminum Alloy Development

6.3 Aluminum Alloys for Hanford

6.3-3 Creep Testing of aluminum alloys for Hanford: Creep tests continuing.

6.4 Aluminum-Uranium Alloys for Savannah River

6.41 Production of Aluminum-Uranium Alloy Castings for SRO: Work is directed at refinement of techniques and at supplying billets and jackets for extrusion into clad tubing. This program appears to be moving smoothly.

6.42 Evaluation of Al-U alloy castings for SRO: A bar cut from a large casting has been examined in detail for homogeneity by means of macroetching, hardness surveys, microstructure, density measurements, and chemical analyses. Hardness versus cold work data has been obtained for a melt cast with 2S aluminum and for a melt cast with 99.9% purity aluminum. Microhardness data has been obtained on a specimen taken from a small, clad extruded tube.

A series of small melts ranging from 7.5 to 20 wt.% uranium has been prepared. Radiographs have been made and the ingots are being sectioned for density, chemical analysis and microspecimens. The possibility of correlation between density and chemical analysis is being examined in detail.

6.5 Extrusion of Al-U Alloy Sandwich Tubing for SRO:

During extrusion of either aluminum or uranium-aluminum alloys, seizure of aluminum into the cones and dies, etc., causes a poor finish to result. Cones of many different materials have been tried including magnesium, copper, cast iron, graphite, and wood. (The wood cones burned away during the extrusion.) Graphite appears most promising.

The effect of temperature of tools on the surface is being examined. Heated soft steel cones gave poor results while one extrusion with graphite cones was successful. Two attempts to repeat the latter were not successful.

Several drawing lubricants have been tried on 3" diameter aluminum tubing but with no outstanding success.

Several types of magnesium alloys have been obtained from which canning tubing will be fabricated for jacketing the Al-U alloy sandwich billets for extrusion. From the recently obtained extrusion constants for magnesium and 2S aluminum, it appears that they have similar extrusion properties between 600° to 1000°F. Magnesium may not be the best jacketing material but in tests to date it has shown most promise in maintaining a good underlying surface of aluminum.

Work continues on attempting to eliminate the "dog bone" effect at the end section of the fuel alloy on the extruded sandwich tubing. It is contemplated to test a plug of 7 wt.% Si-Al alloy (which extrudes similarly to the U-Al alloy "meat") placed in the composite billet before extrusion which should cut off or prevent the "dog bone" effect.

Two-inch diameter 2S aluminum billets have been extruded with a 0.012" silver plate jacket. These extrusions were successful inasmuch as the underlying aluminum was smooth and the silver cladding completely covered the entire extruded shape. A 6" diameter billet will next be silver plated and extruded.

7. Ceramics

Routine crucible fabrication continues.

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