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**QUARTERLY PROGRESS REPORT  
A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS  
JULY 1, 1965 - OCTOBER 1, 1965**

**THE STAFF OF METALLURGY DEVELOPMENT SECTION  
REACTOR AND MATERIALS TECHNOLOGY DEPARTMENT**

AMPTIAC

OCTOBER, 1965

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QUARTERLY PROGRESS REPORT  
A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS  
JULY 1, 1965-OCTOBER 1, 1965

By

The Staff of Metallurgy Development Section  
Reactor and Materials Technology Department

Sponsored by the National Aeronautics and Space Administration  
Project Management at Washington, D. C.  
J. W. Maltz, Office of Advanced Research and Technology

October, 1965

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INTRODUCTION

Tchnetium is a sister element to rhenium and has many properties that are similar to rhenium. It is predicted that technetium will have about the same effects on tungsten as rhenium in regard to increase in workability, lowered ductile to brittle transition temperature, and improved ductility.

The objectives of the current work are to recover technetium from fission product wastes at Hanford and reduce to purified metal; prepare W-Tc alloys containing up to 50 at. % Tc; fabricate the alloy ingots to sheet stock, assessing the effect of technetium on workability; and perform metallurgical and mechanical property evaluation of the fabricated alloys.

Previous reports have described the separation and purification of 800 g of technetium metal powder, melting of technetium and W-Tc alloys, and some properties of the arc cast alloys.

CURRENT PROGRESS

During the past quarter remelting of the alloys was begun using a 10 kW electron beam evaporator unit in an effort to eliminate porosity observed in the arc cast material. In this unit the buttons are melted in a four-compartment water-cooled copper crucible at a pressure of approximately  $5 \times 10^{-7}$  Torr. Two pure tungsten and the 5, 10, 20, and 30 at. % Tc alloys were melted. During melting of the 30 at. % alloy burn through of the copper crucible occurred, requiring complete clean up of the chamber and replacement of the crucible and parts of the electron gun assembly. This work was performed within a complete enclosure of the chamber and under fresh air mask radiation procedures due to the high technetium activity. The equipment is back in operation and several melts of a W-25 at. % Re alloy have been made to improve the melting technique. Well formed buttons

Well formed buttons  
of the 30 at. % alloy

with smooth, regular surfaces were made and radiographs of these revealed no internal porosity. The W-Tc alloys previously remelted were irregular in shape and would be difficult to fabricate, so will be melted again. Losses of approximately 3 g of the 30 to 35 g alloy buttons occurred and was due primarily to splatter during melting rather than to evaporation.

Arc melted alloys contained 50 at. % (35 wt%) and 60 at. % (45 wt%) Tc were examined with an electron beam microprobe\* in attempts to determine compositions within the second phase regions of these alloys. Typical regions examined are shown in Figures 1 and 2 for the 50 at. % alloy and in Figures 3 and 4 for the 60 at. % alloy. Composition variations within the grain boundary areas (darkened) of the 50 at. % alloy or within the matrix areas of the 60 at. % alloy were not resolved to determine whether these areas were alpha plus sigma or single phase sigma. It was shown that this region was of higher average technetium content than the matrix in the 50 at. % alloy and that the matrix was of higher average technetium content than the dendritic second phase of the 60 at. % alloy. The composition of the dendritic second phase shown in Figures 3 and 4 was determined to be 38 wt% Tc, which is in good agreement with the maximum solubility of technetium in tungsten determined from lattice parameter measurements of the as cast alloys. The average matrix composition was determined to be 49 to 50 wt% Tc which is less than sigma composition (58 to 60 wt% Tc). These measurements together with observations of the structure, indicate that the nonequilibrium structure of both alloys is alpha solid solution plus a region of alpha and sigma. The configuration of this second region appears eutectic and it is the last region to freeze. This interpretation would place the 60 at. % Tc alloy as hypoeutectic.

#### Literature Review

No additional information pertaining to technetium alloys was noted during this reporting period.

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\* Work performed by W. F. Selezny, Phillips Petroleum Co., Idaho Falls, Idaho.

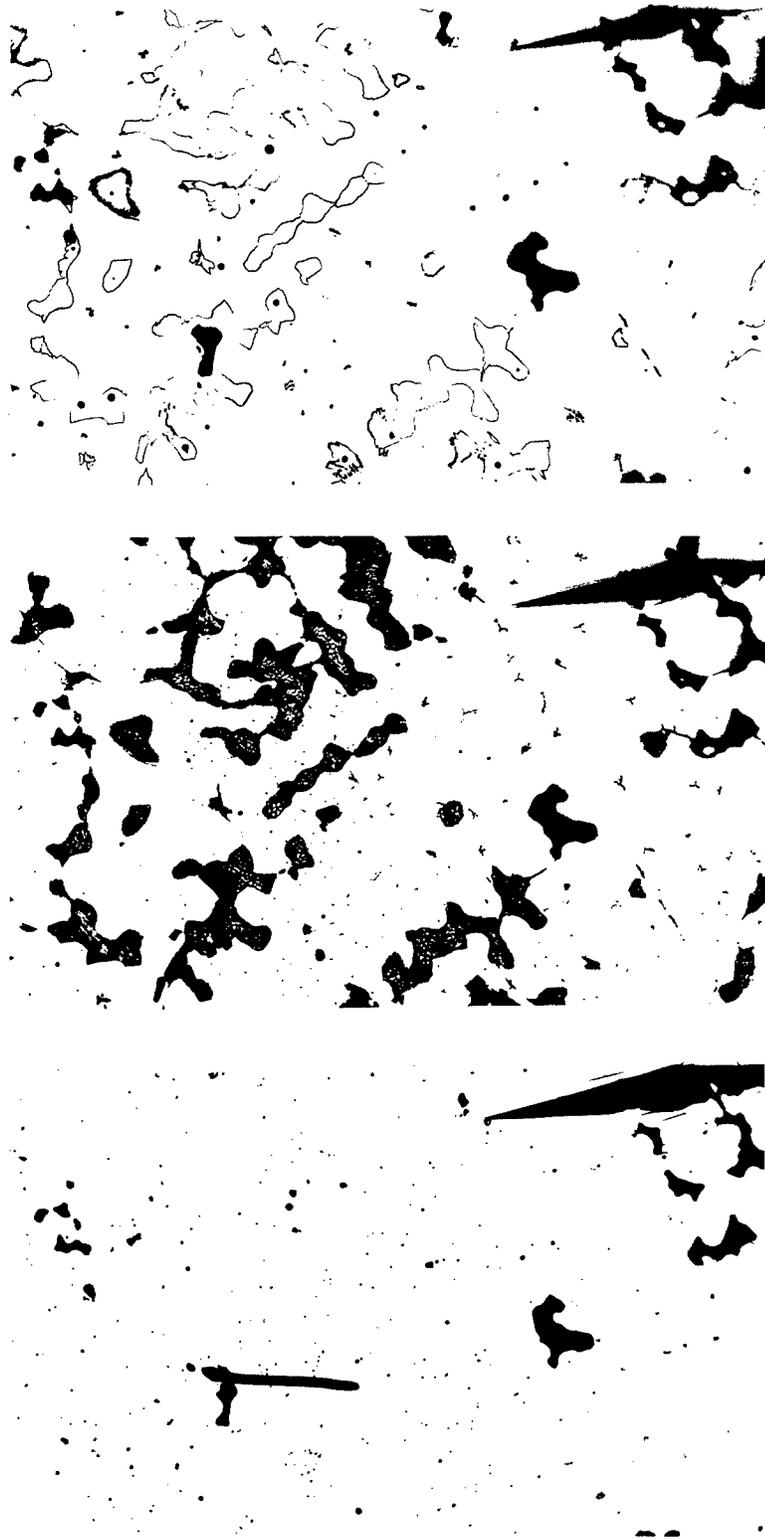


As-Examined

Etched with Murakami's Etch

Further Etch with NaOH Etch

**FIGURE 1**  
 Location of Microprobe Analysis  
 W-50 at. % Tc Alloy  
 250X



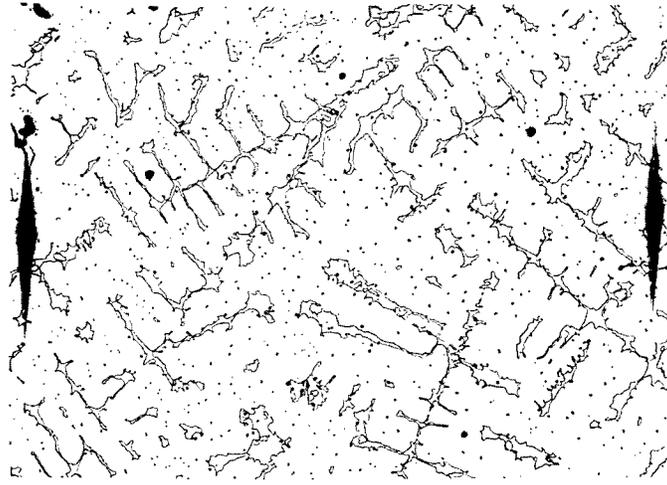
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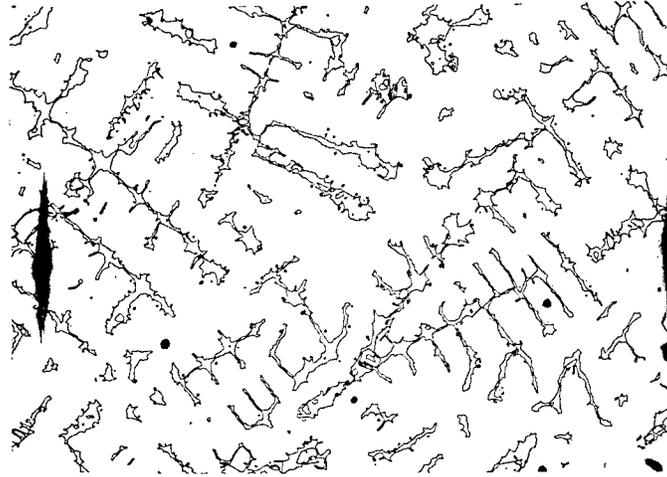
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FIGURE 2

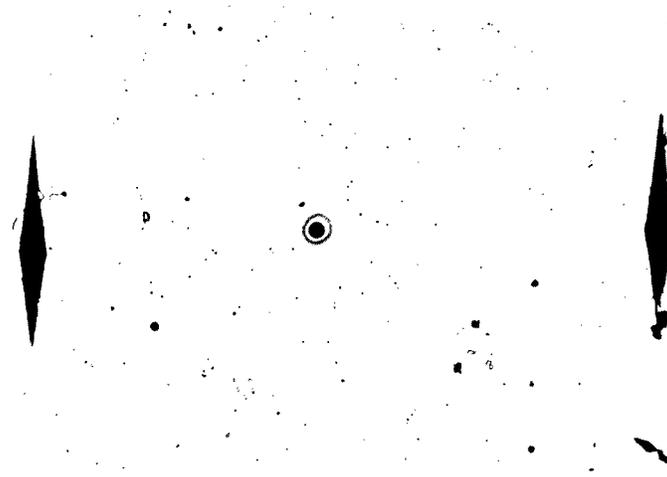
Location of Microprobe Trace  
W-50 at. % Tc Alloy  
250X



Further Etch with NaOH Etch



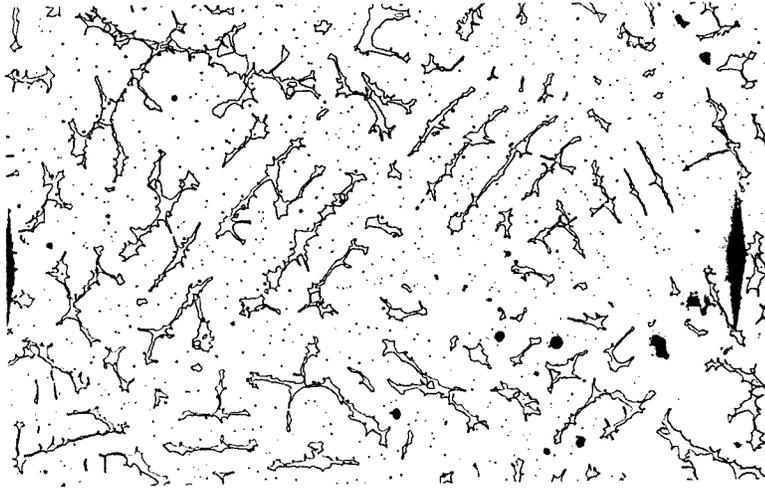
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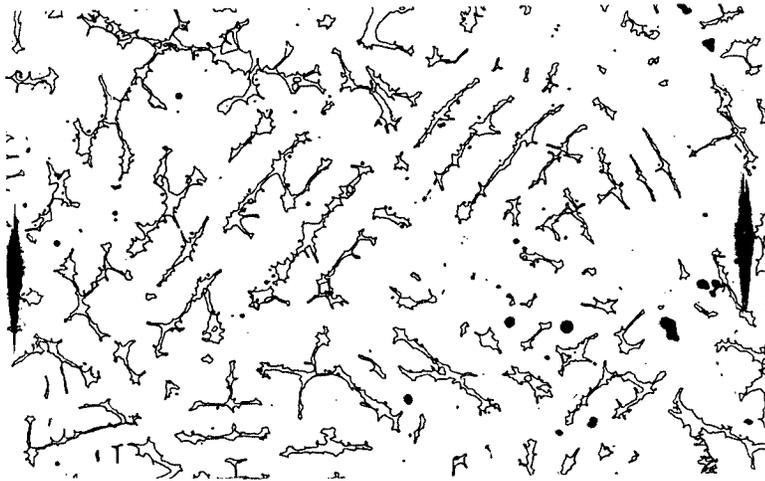
As - Examined

FIGURE 3

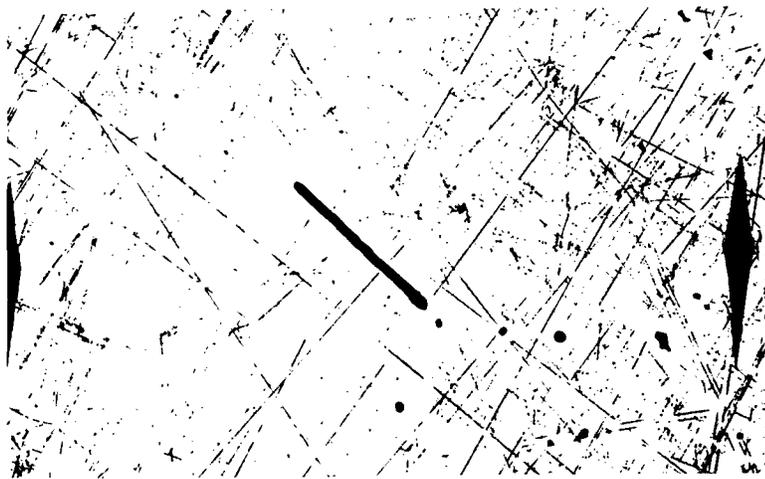
Location of Microprobe Analysis  
W-50 at. % Tc Alloy  
250X



Further Etch with NaOH Etch



Etched with Murakami's Etch



As-Examined

FIGURE 4

Location of Microprobe Trace  
W-60 at. % Tc Alloy  
250X

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