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# Thoria Dispersion in Uranium

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## ABSTRACT

In an attempt to disperse thoria uniformly in uranium, uranium was melted in contact with a thoria-nickel master alloy up to 800°C. The thoria particles were found to have agglomerated and segregated in the U-Ni.

## I. INTRODUCTION

An experiment was performed to determine whether a uniform dispersion of thoria can be produced in uranium by melting uranium with a master alloy of 7 v/o thoria dispersed in nickel. The thoria particles range from 0.01 to 0.5 micron in diameter. To minimize the amount of agglomeration that might occur in the liquid phase, melting was effected up to 800°C. Evaluation of the melted material showed that the thoria particles segregate and agglomerate in molten U-Ni.

## II. EXPERIMENTAL PROCEDURES

A uranium cylinder (stock 7S-1860), 3/4-inch diameter by 1-inch long, was placed on top of a cylinder of the thoria-containing nickel (stock 4297-59D), 3/4-inch diameter by 1/4-inch long, in a graphite crucible surrounded by a quartz vacuum system in a resistance furnace. The uranium had been plated with 1 mil of nickel to maintain a clean surface during heating and to promote melting. To achieve melting at minimum temperatures, 800°C, 60° above the eutectic temperature, was chosen for this experiment. Heating for 1 hour at 800°C led to melting of about two thirds of the metal charge. In a similar run made with ordinary nickel, the metal melted completely.

The melted material was prepared for optical metallography by grinding and polishing. For examination by electron microscopy, necessitated by the small particle size, the specimens were electropolished in an orthophosphoric acid electrolyte for 30 seconds at 25 volts.

## III. RESULTS

A cross-section of the melted thoria-containing specimen is represented in Fig. 1. This specimen contains the four distinct regions described below: the two unmelted starting materials and the two eutectic regions, which differ in thoria content. The companion sample made with ordinary nickel melted completely and showed the expected eutectic structure.

Region 1, the unmelted uranium

The microstructure of the unalloyed uranium was essentially free of small "second phase" particles except for the expected carbides (Fig. 2).

Region 2, the unmelted thoria-containing nickel

The unmelted nickel contains a high thoria particle density uniformly distributed (Fig. 3).

Region 3, a dark band around the unmelted thoria-containing nickel (This material was melted and its external dimensions approximated those of the original nickel section.)

This region is composed of U-Ni eutectic and the thoria particles (Fig. 4). As evidenced by the sharp demarcation between Regions 3 and 4 in Fig. 4, the thoria particles did not mix in the bulk of the molten eutectic alloy. Upon freezing of the thoria-containing region of the eutectic, the thoria was rejected by one of the eutectic components (probably the uranium-rich phase), thereby destroying the uniform particle distribution (Fig. 5, a and b). In addition to segregating, the thoria showed a tendency to agglomerate.

Region 4, the bulk of the eutectic material that had melted

This region is also composed of the U-Ni eutectic, but is relatively free of the thoria particles observed in the portion of the eutectic melt around the unmelted nickel. Those thoria particles present have segregated into patches (Fig. 6, and b).

## IV. CONCLUSIONS

(1) Thoria particles do not readily mix with molten U-Ni at 800°C.

(2) The thoria particles tend to agglomerate in molten U-Ni at 800°C.

(3) During the freezing, the thoria particles are segregated into one of the eutectic components.

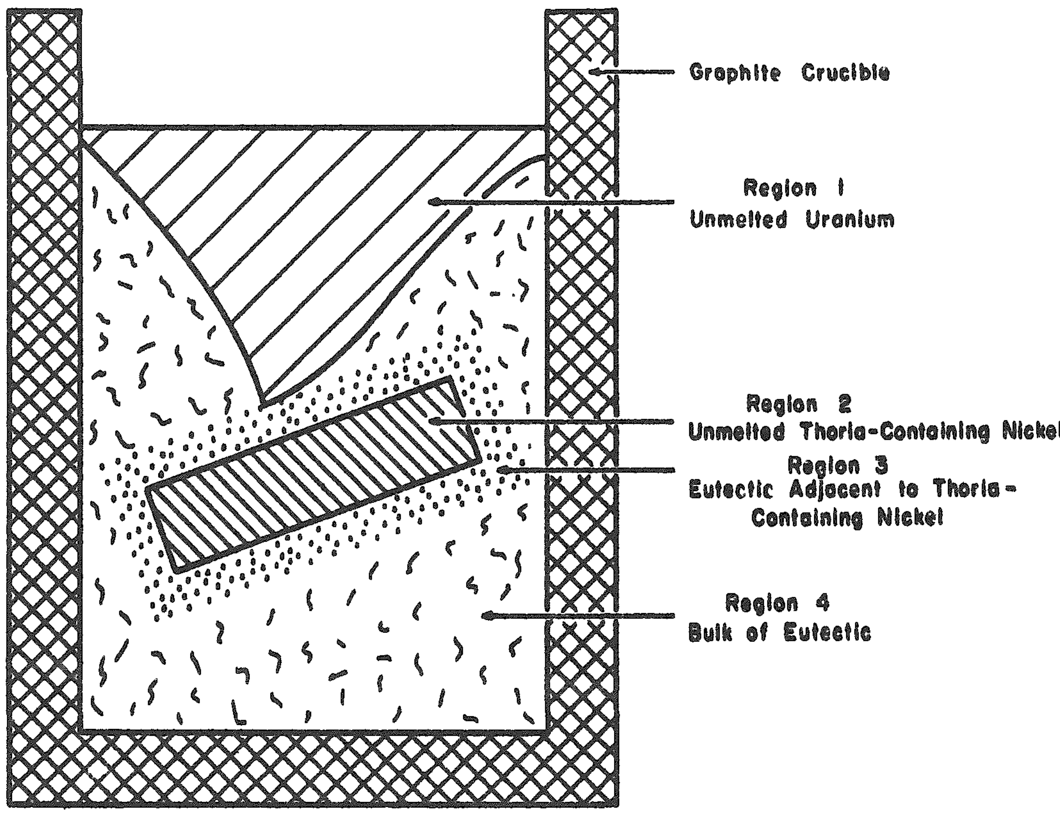
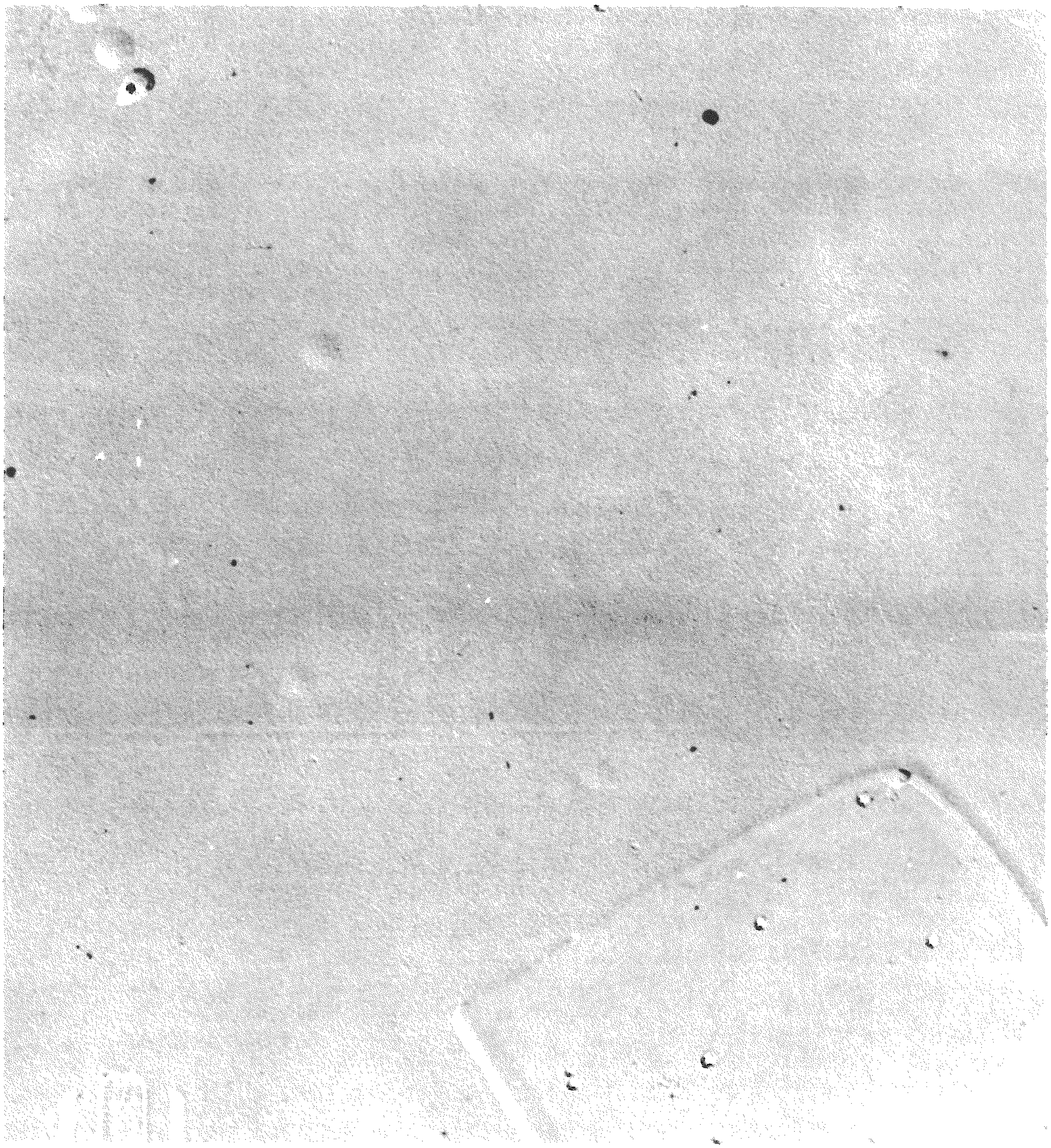
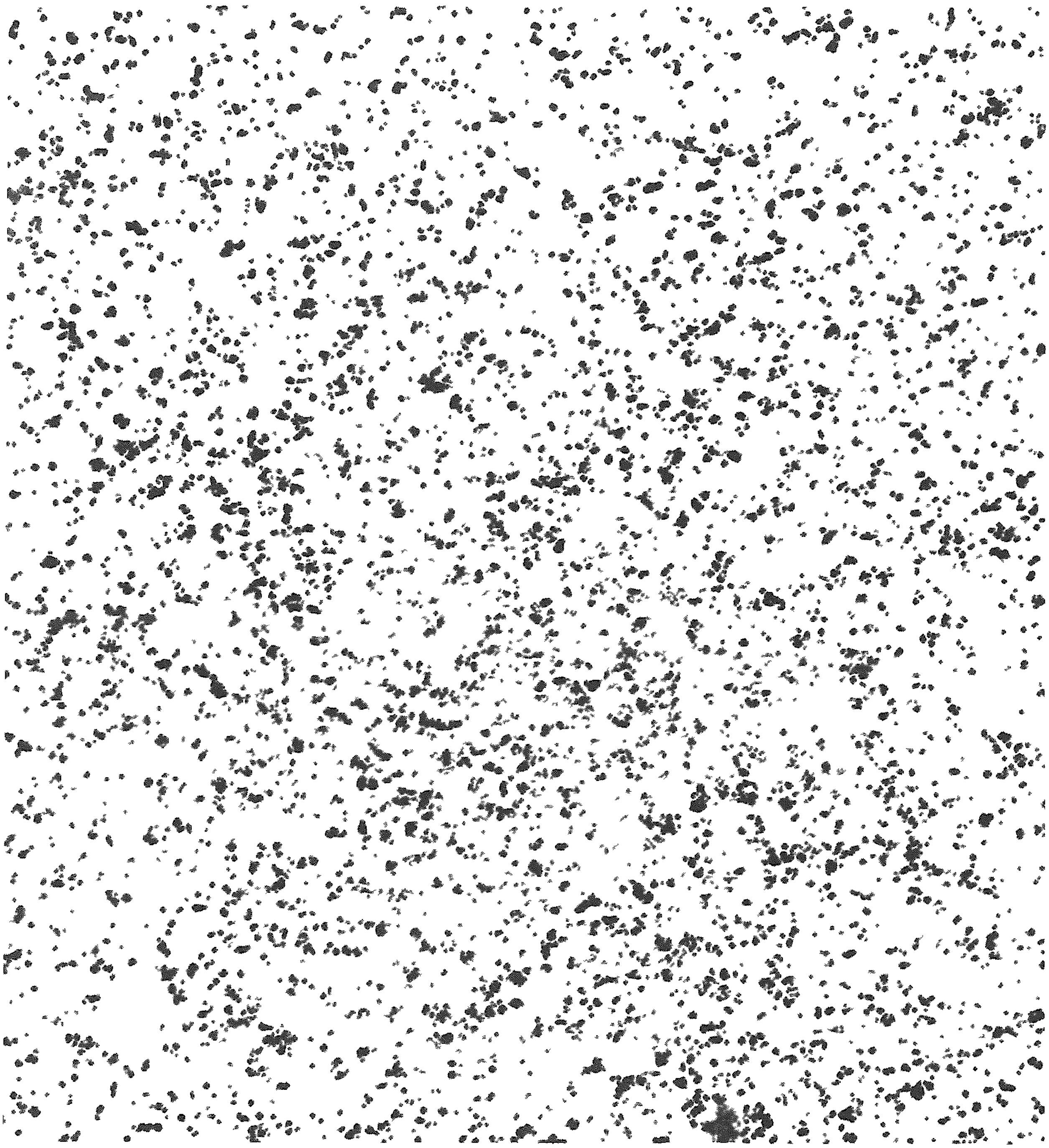



Fig. 1 - Cross-section of melted couple of uranium with thoria-containing nickel. Drawing No. RA-2505.



15,000X 3077

Fig. 2 - Region 1, unmelted dingot uranium. Material is relatively free of "second phase" particles except for carbides (lower right-hand corner).



4000X 1200

Fig. 3 - Region 2, unmelted thoria-containing nickel. Thoria particles 0.01 to 0.5 micron in diameter uniformly distributed.

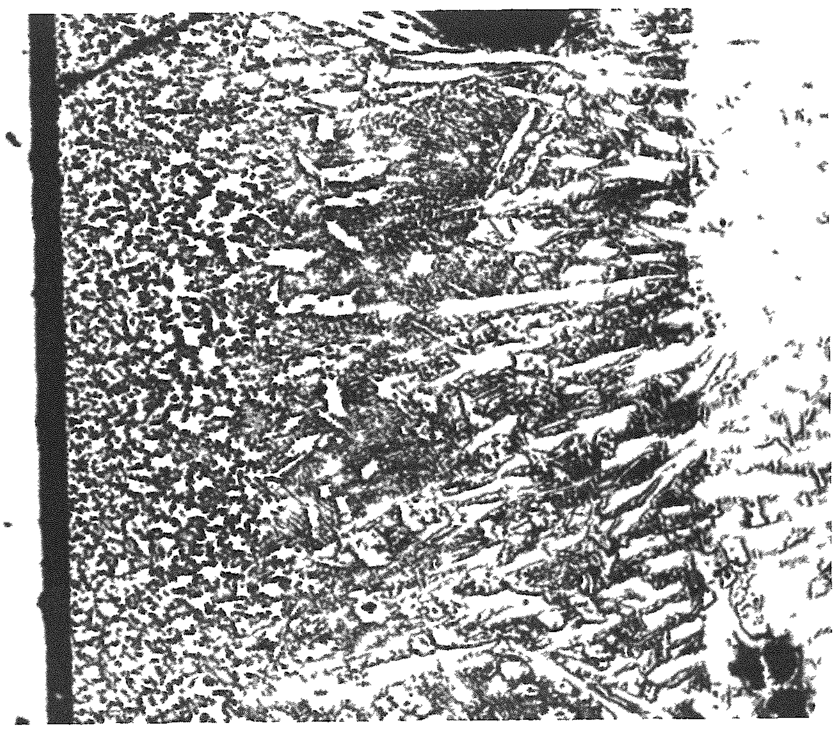
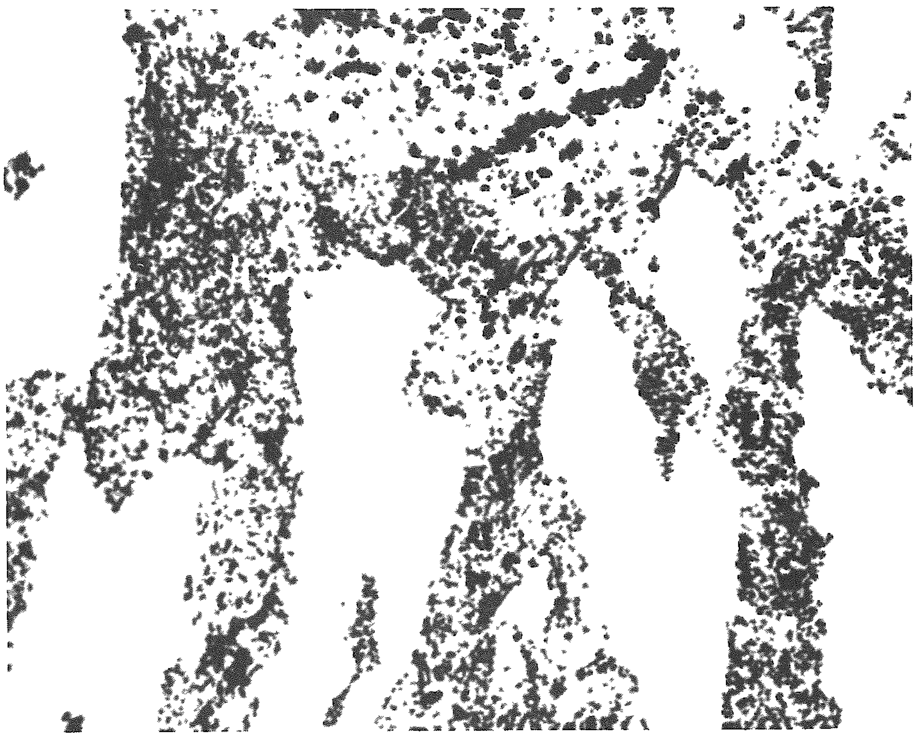


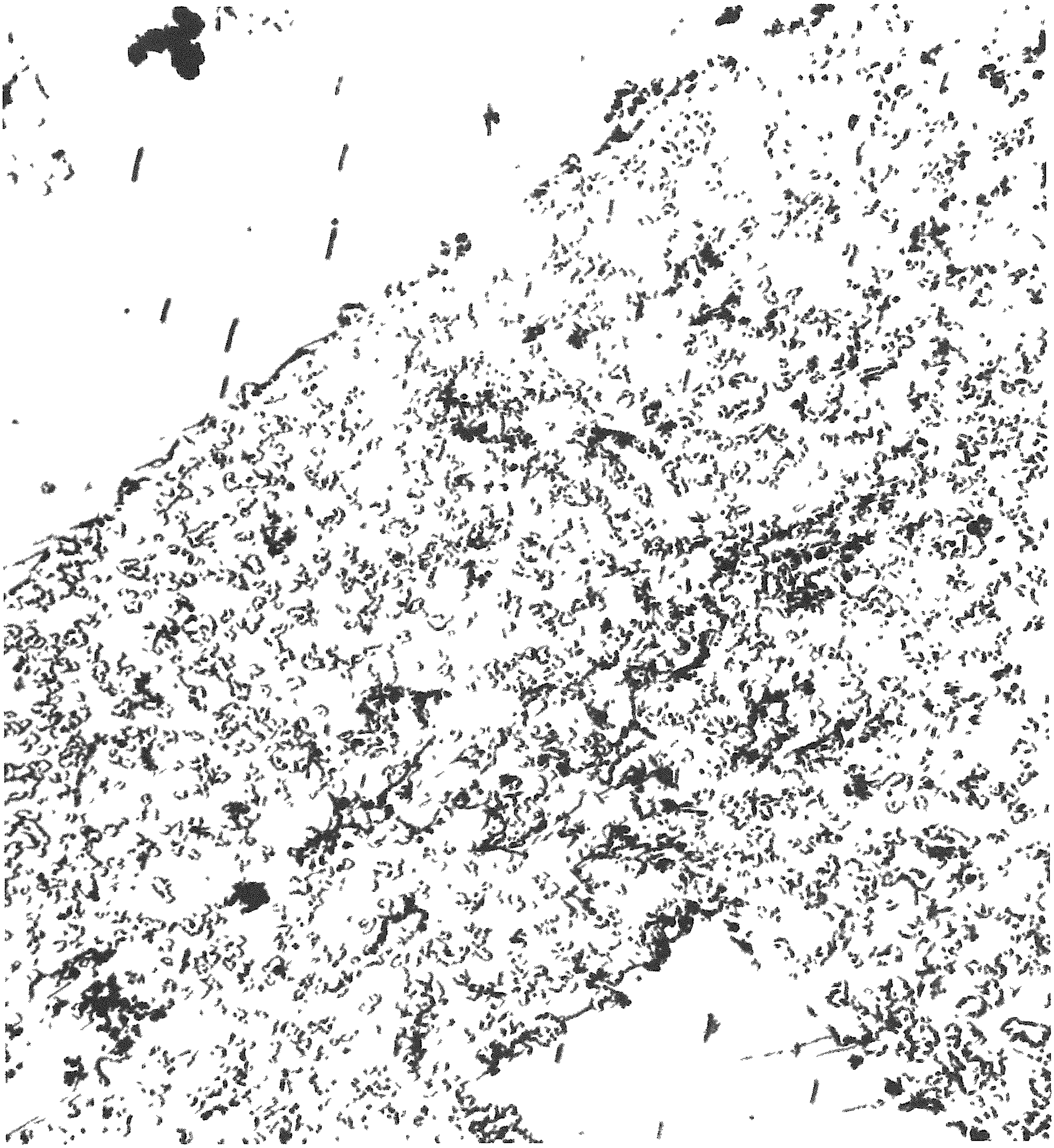

Fig. 4 - Region 3, U-Ni eutectic adjacent to unmelted thoria-containing nickel. 100X. A-4248-a.



A-4248-c

(a) 1000X.

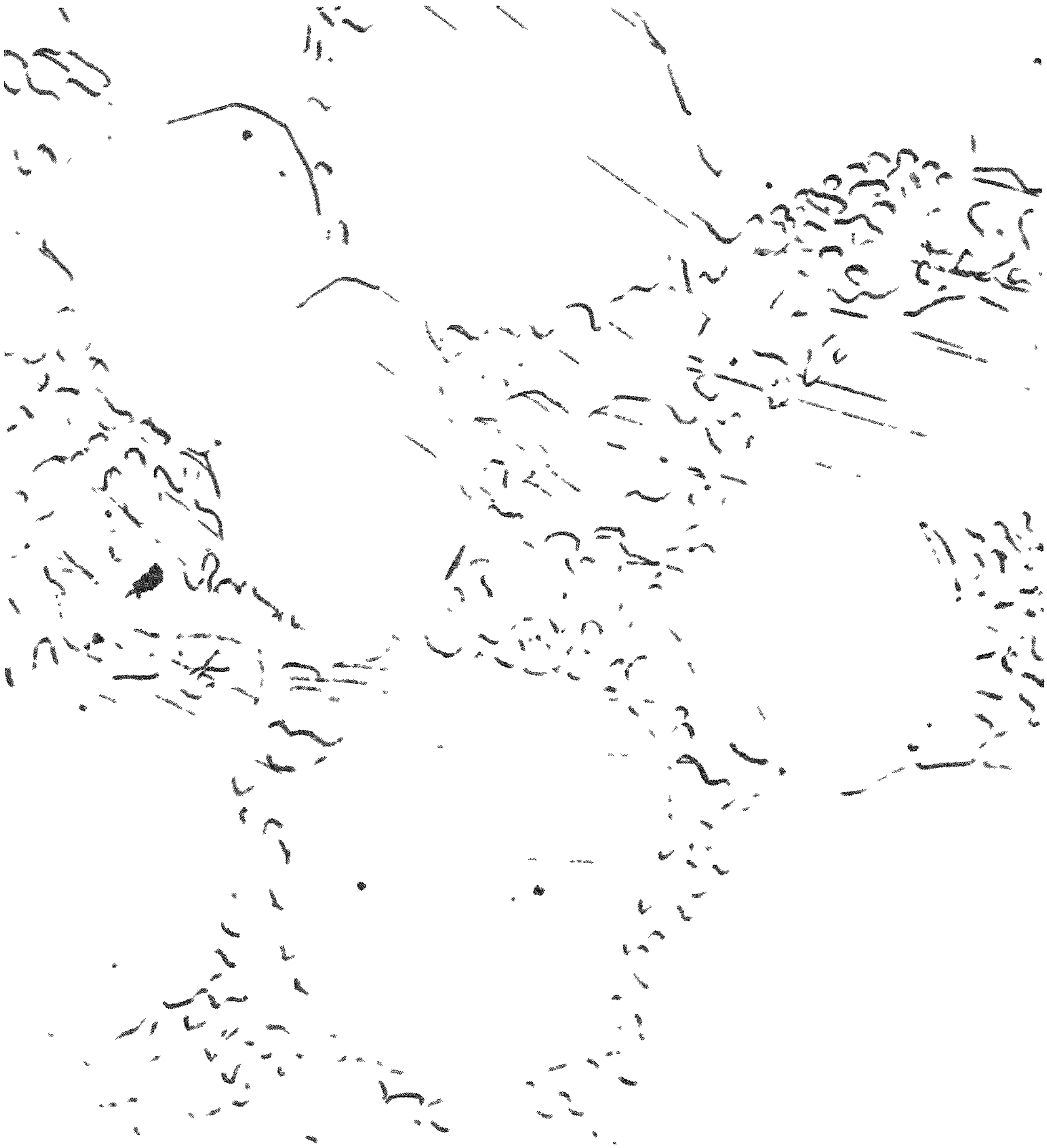
Fig. 5 - Region 3, segregation of thoria in eutectic.



1205

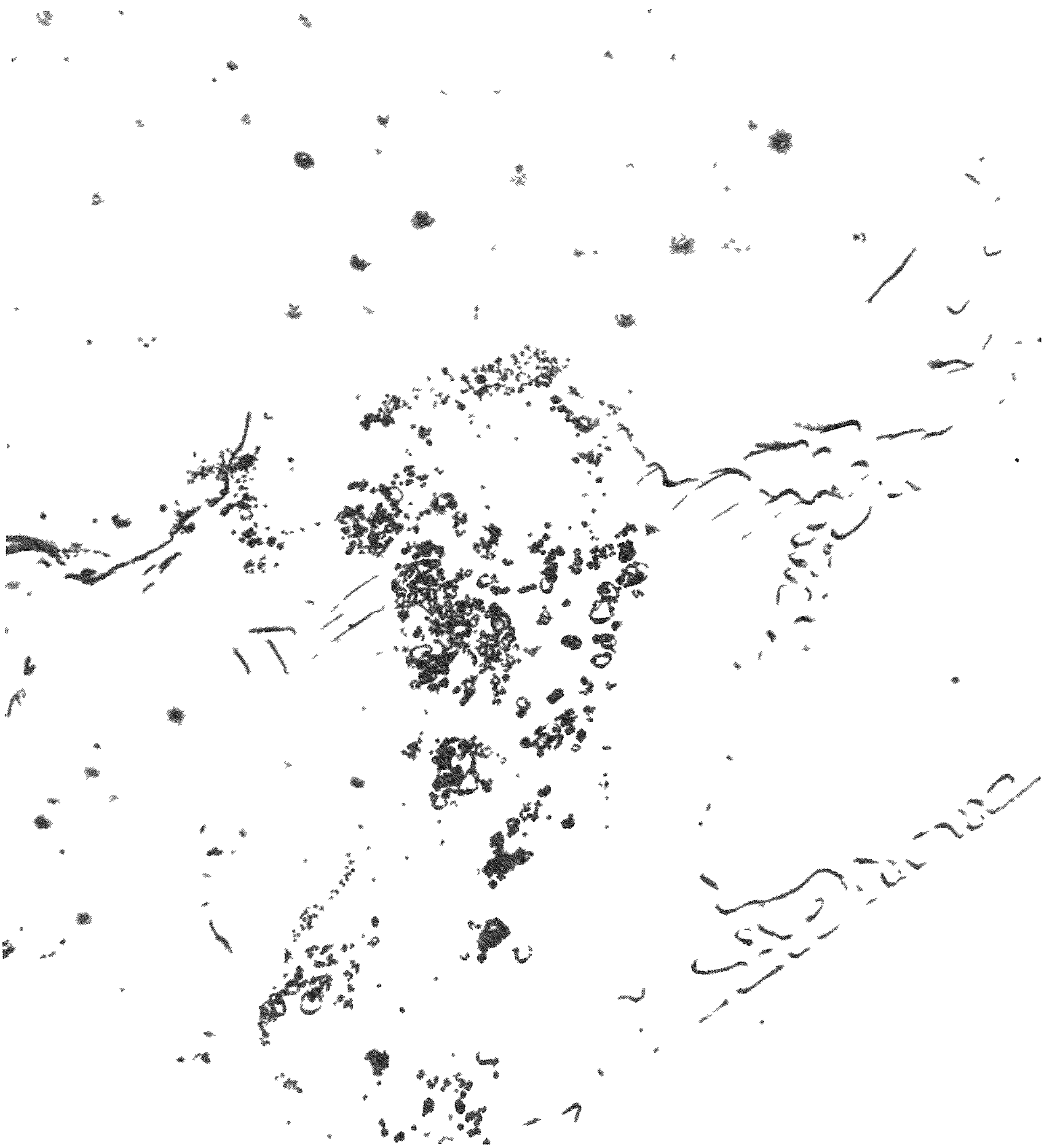
(b) 4000X.

Fig. 5 (continued)




(a) Major portion of Region 4 contains no thoria.

Fig. 6 - Region 4, bulk of U-Ni eutectic.



4000X 1199

(b) Few thoria particles in isolated patches.

Fig. 6 (continued)