HW--59408

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CHEMICAL REACTIVITY OF URANIUM MONOCARBIDE AND URANIUM MONONITRIDE WITH WATER AT 100° C

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INTRODUCTION

The monocarbide and the mononitride of uranium are potentially useful ceramic nuclear fuel materials. This paper reports the results of exploratory investigations of the reactions of uranium monocarbide and uranium mononitride with boiling water. Uranium dioxide, chemically stable in deoxygenated boiling water, was used as a control.

EXPERIMENTAL

Materials

The materials used were minus 200 mesh powders. The distilled water had a pH of 6.2.

Equipment

The experiments were conducted in 500-cc round-bottomed flasks fitted with vertically mounted reflux condensers and heated by mantles. The materials were collected by suction filtration on previously weighed, Buchner-type, fritted-glass funnels. Materials and funnels were weighed on an analytical balance. The pH of the water was measured using a Beckman meter.

Procedure

The material to be studied was weighed and added to 200-cc of distilled water contained within the flask. The condenser was attached and the temperature of the water was held at the boiling point for 24 hours, then cooled to room temperature. The solid material was recovered by suction filtration. The crucibles were reweighed after drying in a desiccator. The filtrate was analyzed for dissolved uranium and the pH redetermined. The powder was examined by electron microscopy and X-ray diffraction techniques. The extent of the reaction was determined from the weight of the material recovered, the change in the surface morphology and crystal structure of the powder, the amount of dissolved uranium in the filtrate, and the change in the pH of the distilled water.

RESULTS

The experimental results are assembled in Table I. Figures 1, 2, and 3 illustrate the surface morphology of the particles before and after heating in boiling water.

The amount of material not recovered is considered to be less than the experimental error of the technique. In particular, the uranium monocarbide formed a greyish-green slime on the sides of the flask, which made total recovery difficult. The X-ray and electron microscopy results show that uranium monocarbide reacted with water to form uranium dioxide. Uranium dioxide was insoluble under the experimental conditions. Uranium mononitride remained unaffected by the boiling distilled water.

CONCLUSIONS

Uranium monocarbide powder reacts with boiling, distilled water to form uranium doixide. Uranium mononitride is unaffected by heating in boiling, distilled water for 24 hours.

FUTURE WORK

Uranium mononitride will be heated in boiling distilled water or steam for longer periods of time. Cladding compatibility studies are planned.

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TABLE I

URANIUM MONOCARBIDE AND URANIUM MONONITRIDE HEATED IN BOILING DISTILLED WATER FOR 24 HOURS

Weight of Starting Material, g	Recovered Material				Filtrate	
	Weight, g	Weight loss, g	X-Ray Analysis	Electron Microscopy Analysis	pH(1)	Dissolved Uranium
Uranium Monocarbide-43.2883	38.6931	4.5952(2)	Uranium Dioxide (Fluorite Structure)	Attacked	6.8	None
Uranium Mononitride-39.0934	38.6332	0.4602(2)	Uranium Mononitride (Sodium Chloride Structure)	No Attack	6.8	None
Uranium Dioxide-42.7059	41.4261	1.2798(2)	Uranium Dioxide (Fluorite Structure)	No Attack	6.8	None

(1) The pH of distilled water which had been boiled for 24 hours is 6.8.

(2) Less than experimental error.

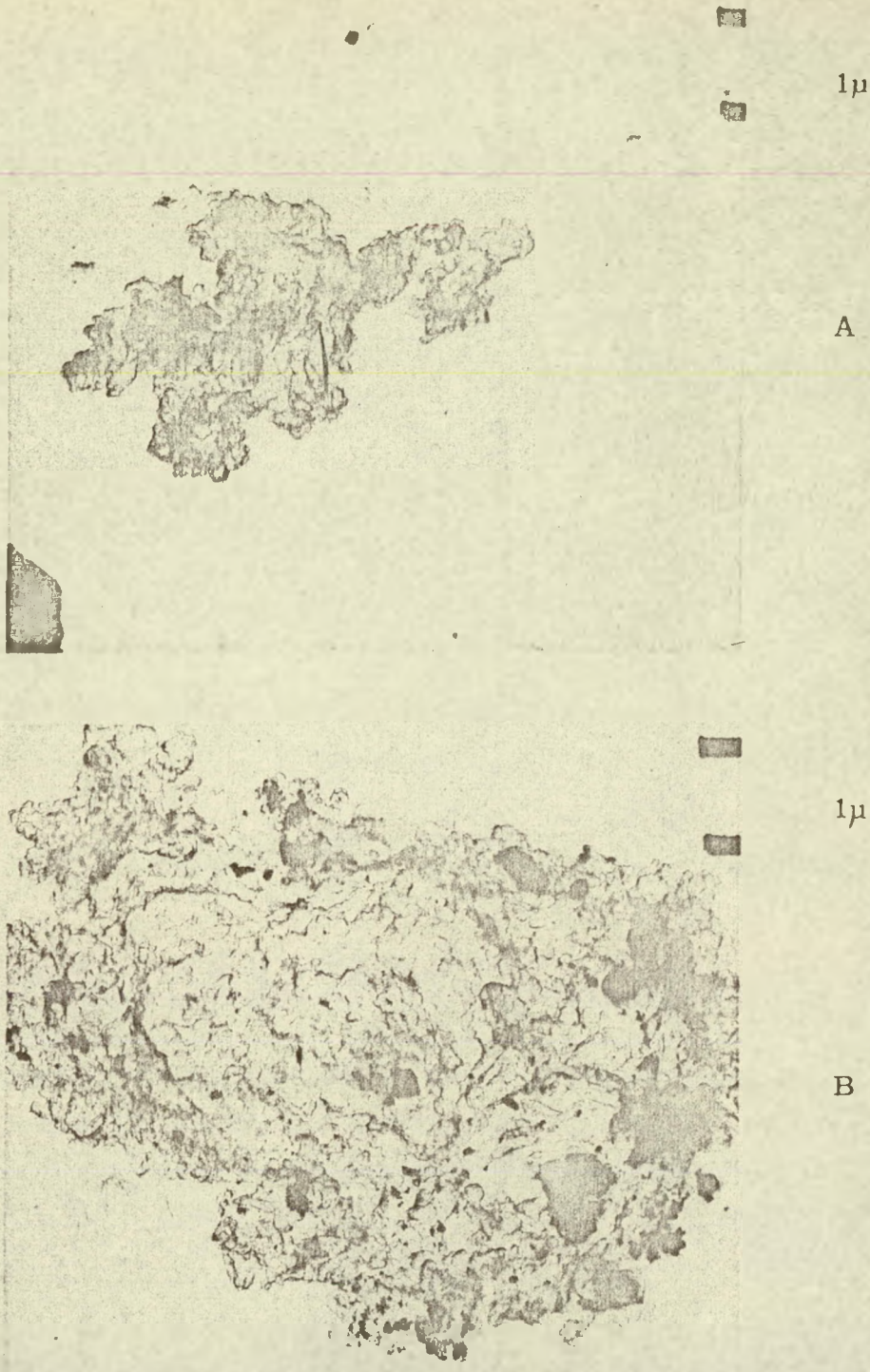

FIGURE 1

UC Powder (A) Before, (B) After Being Heated in Boiling Water for 24 Hours

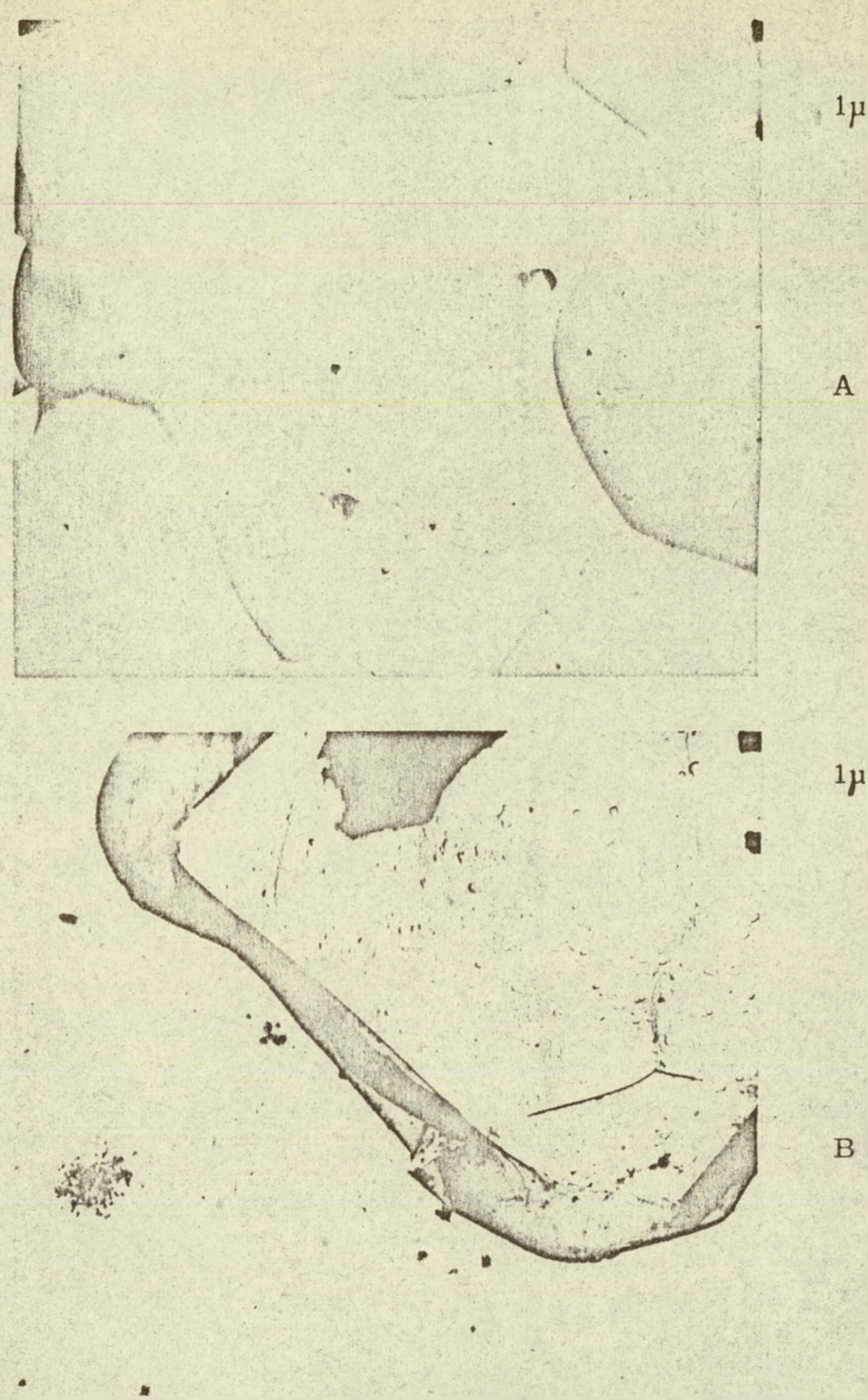

FIGURE 2

UN Powder Heated in Boiling Water for 24 Hours (A) Before (B) After

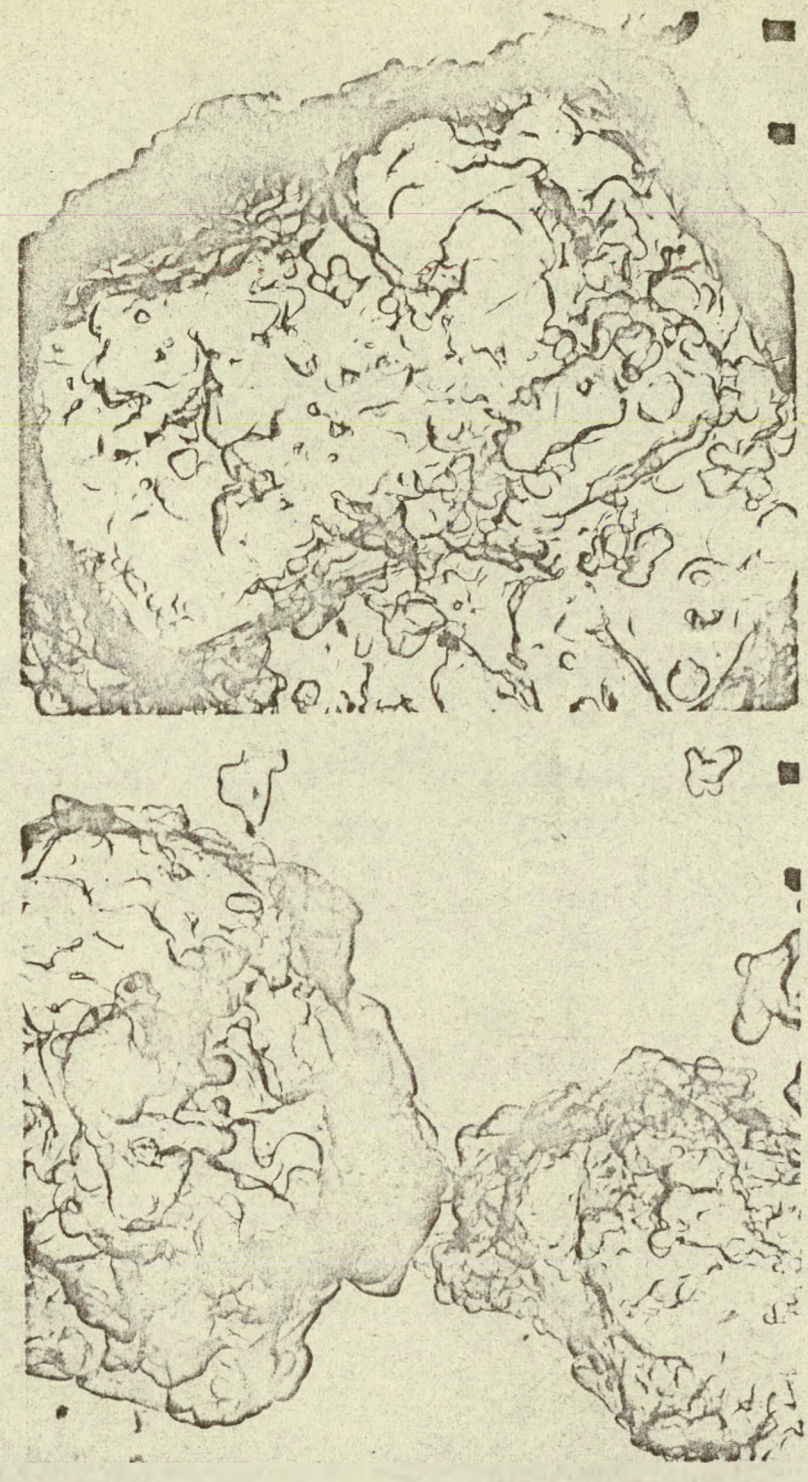

FIGURE 3

UO_2 Powder Heated in Boiling Water for 24 Hours (A) Before, (B) After