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REPORT ON ZIRCONIUM NITRIDE

322
NEPA-IHR-E7

TECHNICAL INFORMATION DEPARTMENT

INFORMATION AND HANDBOOK SECTION

November 11, 1947

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1.00 INTRODUCTION

The information and data pertaining to ZrN is limited and meager. This compound is not used in any applications; however, it is being considered for use in high temperature applications pending further investigatory work. ZrN is characterized by a high melting point (5300°F) and extreme hardness.

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2.00 PROPERTY DATA

References

2.01 Chemical Composition

- a) Molecular Weight 105.23 (calc.)
- b) Molecular Formula $ZrW. (Zr_3N_2)(Zr_2N_3)(Zr_3N_4)(Zr_3N_8) (1)(5)$

2.02 Density

- a) True Density 6.93 g/cc - X-Ray data (1)
(0.25 lb/in³)
- b) Apparent density - no data

2.03 Specific Gravity 6.93

(2)

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2.06 Melting Point

- a) $2930^{\circ}\text{C} - (5300^{\circ}\text{F})$ Melts without decomposing. (1)
 $2980 \pm 50^{\circ}\text{C} - (5400^{\circ} \pm 90^{\circ}\text{F})$
- b) 3200°K ($2927^{\circ}\text{C} - 5300.6^{\circ}\text{F}$) (2)
- c) $3255^{\circ}\text{K} \pm 50^{\circ}$ ($2982^{\circ}\text{C} \pm 50^{\circ} - 5399.6^{\circ}\text{F} \pm 122^{\circ}\text{F}$) (3)

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2.14. Electrical Resistivity

a) Specific electrical resistance

3.2 ohms/cc. at 3200°K (2927°C - 5300.6°F)
(1.3 ohms/in. at 3200°K) (2)

1.6 ohms/cc. at room temperature
(0.6 ohms/in. at room temperature)

The nitride is a better conductor than the metal itself; there is a point, where the resistivity reaches a maximum, after which the resistivity will be diminished again. (4)

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2.19 Hardness

8 to 9 Moh's Scale

Reference

(2)

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2.25 Miscellaneous Information

References

- a) Cubic NaCl type (1)
Lattice Constant a - 4.61 (1)
a - 4.63 (3)
- b) Heat of formation 82 K calories per (gram)mol.
[328,000 B.T.U. per (pound) mol.]

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3.00 FABRICATION DATA

- No available information or data

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4.00 PREPARATION

References

4.01 Methods of Preparation of the Compound or Element (5)

Zirconium shows a strong affinity for nitrogen. The metal readily combines with it when heated in a stream of nitrogen or when heated in air. The nitrides reported are Zr_3N_2 , Zr_2N_3 , Zr_3N_4 , and Zr_3N_8 . In addition there are the amide $Zr(NH_2)_4$ and the imide $Zr(NH)_2$.

The compound $ZrCl_4 \cdot 8NH_3$ gives off abundant fumes of ammonium chloride when heated to redness in a stream of nitrogen. The residue, a pearl-gray powder, yielded ammonia when heated in a stream of hydrogen. The nitrogen present was determined by dissolving this gas in a standard solution of hydrochloric acid. The residue was burned to zirconia and weighed. The analysis corresponds with the formula Zr_3N_8 . When $ZrCl_4 \cdot 4NH_3$ was treated in the same way the analysis of the product gave Zr_2N_3 .

Nitrogen reacts with pure powdered zirconium at 1050-1086°C (1922-1976°F) to form Zr_3N_2 .

All ammonium compounds react with zirconium tetrachloride to yield $Zr(NH_2)_4Cl_4$ on heating to 195°C (383°F). This is true also of the iodide. At higher temperatures the halogen acid and not ammonia is given off.

Thus at 225° - 250°C (437° - 482°F) the amide $Zr(NH_2)_4$ is formed in an atmosphere of hydrogen or ammonia. Above 250°C (482°F) the product seems to be a mixture of an imide and a nitride, $Zr(NH)_2 + Zr_3N_4$. At 350°C (662°F) only the Zr_3N_4 remains. This is insoluble and unchanged in water.

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5.00 ANALYSIS

No. available information or data

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6.00 EQUILIBRIUM STUDIES WITH OTHER ELEMENTS AND COMPOUNDS

No available information or data

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7.00 STRUCTURAL STUDIES AND CHANGES IN PROPERTIES UNDER EXPOSURE TO RADIATION

No available information or data

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8.00 NUCLEAR DATA

No available information or data

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