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1

REFRACTORY OXIDE MELTING POINTS

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This document is

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2

ABSTRACT

The melting points of the following oxides were determined and checked:
 Al_2O_3 - $2034 \pm 16^\circ \text{C}$, La_2O_3 - $2210 \pm 20^\circ \text{C}$, Nd_2O_3 - $2272 \pm 20^\circ \text{C}$, ZrO_2 - $2710 \pm 15^\circ \text{C}$, UO_2 - $2878 \pm 22^\circ \text{C}$, and ThO_2 - $3220 \pm 50^\circ \text{C}$.

INTRODUCTION

In the course of our ceramic research at the Argonne National Laboratory a number of the refractory oxides were melted and measurements were taken of their melting points. The limits of error given are arbitrary limits imposed by the authors rather than limits of the method or equipment. Greater accuracy can be obtained by making additional heats about the determined melting points.

METHOD

The samples were melted in a tungsten resistance-heated, helium atmosphere furnace using tungsten crucibles. At first the crucible was filled with oxide so that it could be seen as it was melted. Additional crucibles of the material were heated with a small amount in the bottom of the crucible and black body conditions were obtained. The final melting temperature was determined with samples heated above and below the final listed temperature that did and did not melt. It was an easy matter to examine the samples after heating and decide whether or not they had melted.

Possible sources of error consist of those in the optical pyrometer, sight glass calibration, human reading error, and error in the furnace controls which permitted overshooting of the control temperature. The optical pyrometer was calibrated by the Bureau of Standards and was reported to have a maximum uncertainty of eight degrees at 2800°C . A fused silica sight

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3

-2-

glass was used and its absorption calibrated with a General Electric tungsten filament calibration bulb to 2200° C and extrapolated to higher temperatures. Above 2800° C a Bausch & Lomb inconel neutral filter was used which had an optical density of 0.6. The maximum error observed during the calibration of this filter was 9° C. Human error was reduced by having an experienced operator read the control temperature at least five times and using the average reading. With these precautions the maximum error in checking the platinum melting point was 2.5° C.

DISCUSSION OF RESULTS

The alumina used was T-61 from the Aluminum Company of America and was analyzed by the manufacturer to be 99.5+ percent Al_2O_3 . Alumina was found to melt at $2034^\circ \pm 16^\circ \text{C}$, which is in agreement with the literature. Lanthana and neodymia of 99 percent purity were obtained from the Lindsay Chemical Company. The Lanthana melting point was found to be $2210 \pm 20^\circ \text{C}$, which is slightly lower than the literature value. As no change in the material was detected by x-ray analysis the melting point found is believed to be correct. Neodymia was found to melt at $2272 \pm 20^\circ \text{C}$ with no detectable change in the crystalline structure as determined by x-ray analysis. Zirconia was obtained from the Titanium Alloy Manufacturing Division, National Lead Company, with only 0.03 percent impurities other than hafnium oxide. It contained 2.03 percent hafnium oxide. Zirconia was melted at $2710 \pm 15^\circ \text{C}$ which is in agreement with the literature. Very pure UO_2 was used and its oxygen content determined after melting. Its melting point was found to be 280 degrees higher than the highest literature value. Thoria was melted only once so its melting point of $3220 \pm 50^\circ \text{C}$ is given with a higher degree of uncertainty than the other values. However, there is no doubt that the literature value is in error. The thoria used was 99.7 percent pure.

SUMMARY

The melting points of some of the refractory oxides were found to be as follows: Al_2O_3 - $2034 \pm 16^\circ \text{C}$, La_2O_3 - $2210 \pm 20^\circ \text{C}$, Nd_2O_3 - $2272 \pm 20^\circ \text{C}$, ZrO_2 - $2710 \pm 15^\circ \text{C}$, UO_2 - $2878 \pm 22^\circ \text{C}$, and ThO_2 - $3220 \pm 50^\circ \text{C}$.

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