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THE DEVELOPMENT OF MATERIALS CAPABLE
OF OPERATION IN AN OXIDIZING ATMOSPHERE
FOR EXTENDED PERIODS OF TIME

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16. Abstract

The work performed under this program has been involved with an evaluation of silicon carbide, zirconium diboride, and iridium coated graphite as materials for construction of furnace cores which could operate under highly oxidizing conditions at temperatures of approximately 2,200°C in the presence of molten aluminum oxide. It was found that silicon carbide and zirconium diboride could not withstand oxidizing atmospheres in the presence of aluminum oxide at temperatures of 2,200°C. However, graphite furnace cores coated with iridium were found to be useful furnace cores at 2,200°C in an oxidizing atmosphere for reasonably extended periods of time.

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PREFACE

The objective of the work presented in this report was to investigate materials capable of operation for extended periods of time in an oxidizing atmosphere at 2,200°C in the presence of molten aluminum oxide. The materials to be investigated were silicon carbide and zirconium diboride along with any other materials which might be useful for the production of furnace cores which could be utilized under the conditions mentioned above. Since silicon carbide and zirconium diboride proved to be ineffective materials in an oxidizing atmosphere at 2,200°C it was decided to investigate high density graphite coated with iridium. It was found that this technique yielded furnace cores which could be successfully utilized at temperatures of 2,200°C and an oxidizing atmosphere. The primary conclusions reached from this work are that silicon carbide and zirconium diboride cannot be used under highly oxidizing conditions at temperatures reaching 2,200°C. However, it would be recommended that furnace cores coated with iridium be utilized for such applications.

1.0 INTRODUCTION

This report is the final report on Contract NAS5-21390. The report is concerned primarily with the results of the experimental work performed with silicon carbide, zirconium diboride and high density graphite coated with iridium. The objective of the program was to evaluate these materials for their potential to produce furnace cores which could operate for extended periods of time at 2,200°C in an oxidizing atmosphere in the presence of molten aluminum oxide.

2.0 EXPERIMENTAL AND RESULTS

Considerable experimental work was performed with high density silicon carbide and zirconium diboride before attention was directed to the investigation of high density graphite coated with iridium. However, since the level of effort available for this program was relatively low, experimental effort on the investigation of each material had to be severely restricted in order to achieve the overall goals of the program.

Silicon carbide furnace cores were prepared by hot pressing silicon carbide to a very high density impervious material. The tubes were submitted to the Goddard Space Flight Center for evaluation at 2,200°C in an oxidizing atmosphere. It was found that the silicon carbide furnace cores prepared under optimum hot pressing conditions were still relatively reactive in an oxidizing atmosphere. Chemical analysis of the products of reaction of oxygen with the silicon carbide cores indicated that the silicon carbide was reacting rapidly at 2,200°C to yield primarily silicon dioxide. From this data it became clear that silicon carbide would not be a useful material for further investigation under the temperature and oxidizing conditions selected. Further attempt at producing furnace cores from silicon carbide were therefore discontinued.

The experimental work with zirconium diboride led to essentially the same results as the work with silicon carbide, i.e., oxidation to zirconium oxide. Since the initial zirconium diboride powder was difficult to obtain in a pure form it is possible that these impurities were adversely effecting the hot pressing technique although it is felt that under the temperatures and oxidizing conditions utilized during this investigation zirconium diboride would not be a useful furnace core material.

The experimental work with graphite coated with iridium proved to be more successful for the preparation of furnace cores. In this case a high density graphite was machined to the appropriate dimensions. The purpose of the graphite was simply to serve as a support for two iridium sleeves. Two iridium sleeves were prepared, one for the inner side of the graphite tube and one for the outer side of the graphite tube. The iridium sleeves were prepared by welding sheets of iridium metal to the appropriate dimensions. The graphite tube was then placed between the inner and outer sleeve to construct the furnace core. This technique produced furnace cores which were able to withstand the high temperatures and highly oxidizing conditions under which they were exposed. The furnace cores have been delivered to the Goddard Space Flight Center and are now in use.

3.0 NEW TECHNOLOGY

As indicated in the report submitted under separate cover to the New Technology Division of the Goddard Space Flight Center it is not considered that any new technology was produced under this program.

4.0 CONCLUSIONS

1) It is concluded that furnace cores which can withstand temperatures of 2,200°C in an oxidizing atmosphere cannot be constructed from silicon carbide.

2) It is concluded that furnace cores which can withstand temperatures of 2,200°C in an oxidizing atmosphere cannot be constructed from zirconium diboride.

3) It is concluded that furnace cores which can withstand oxidizing conditions at temperatures of 2,200°C can be constructed from graphite coated with iridium.

5.0 RECOMMENDATIONS

The principal recommendations which can be made at this time would be to investigate better and cheaper methods of preparing furnace cores from graphite coated with iridium. While the cost of iridium is high, it should be noted that since iridium is a precious metal it may be returned to the manufacturer after use and approximately 85% of its original cost is returned to the owner.