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JAN 73 B J MACRI, F FONZI, E L OLCOTT N00017-73-C-4306
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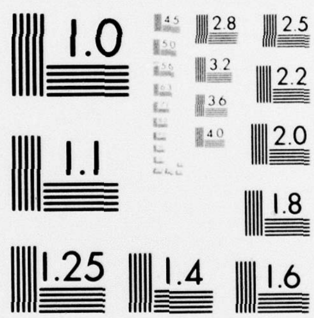

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DEVELOPMENT OF HIGH TEMPERATURE RESISTANT MATERIALS FOR USE IN NAVAL ORDNANCE

Contract No. N00017-73-C-4306

Second Quarterly Report

Submitted to:

Naval Ordnance Systems Command
Department of the Navy
Washington, D. C. 20360

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1.0 INTRODUCTION

During the previous phases of this program, the potential of the Pyrostrand® concept was observed to be worthy of continued development. Pyrostrand is a graphite composite produced by winding a filamentary carbon or graphite reinforcement on a mandrel in a furnace at 3,650°F, while continuously depositing a matrix of pyrolytic graphite. Additional features of this concept include: (1) the simultaneous deposition of carbides (when desired) to modify the matrix structure, (2) the use of filamentary materials of various textile configurations and mechanical properties and (3) the control of reinforcement placement and content for increased strength and greater erosion resistance in very-high-temperature environments.

The pyrolytic graphite matrix has inherently high resistance to erosion under rocket motor firing conditions. A disadvantage of the material is its tendency to delaminate at moderate or excessive thicknesses. This delamination tendency can be reduced by causing the pyrolytic graphite to grow from surfaces other than the substrate, a filamentary reinforcement for example. The high performance graphite yarns have a very high strength/density ratio and thereby offer the potential for producing composites with a significant degree of reinforcement. In contrast to most materials, the strength of both major components of these composites increases with temperature up to near the sublimation temperature of graphite (6,600°F).

Past progress has been limited by a small furnace and a small capacity for handling the filamentary material. The results were sufficiently promising to indicate that further work should be conducted to scale up the equipment for the production of larger pieces and to solve the problems identified in earlier studies. The most important of these problems were: (1) voids inside yarn and at yarn crossing points, (2) growth of pyrolytic graphite on broken filament ends, which prevented smooth winding in subsequent layers and (3) insufficient yarn handling capability to prepare thick specimens.

For advanced propulsion systems throat inserts may be required in sizes up to 12.5 inches throat diameter. Assuming an outside diameter of 14 inches, a furnace diameter of approximately 16 inches is indicated, resulting in a fourfold cross sectional area extrapolation. Transition to a fabrication system of this size and demonstration of 7-inch nozzle fabrication and test are the objectives of this program.

A discussion of the program approach was presented in Reference 1. Work accomplished during the two month report period is described below.

2.0 WORK ACCOMPLISHED

Most of the work accomplished related to the procurement of equipment required for the size scale-up. Company funds were received for the purchase of this equipment.

A new atmosphere control chamber and induction coil have been ordered with a scheduled delivery in late February. An objective in both the control chamber and furnace design was to provide a system suitable for transition to production operation, if required, without significant changes.

The new equipment will consist of three major sections: (1) the vacuum tank to contain the controlled atmosphere, (2) the induction coil and (3) the furnace assembly.

The vacuum tank was designed to be 72 inches in diameter and 60 inches high. It will be constructed from 304 stainless steel in two sections, split horizontally, and provided with flanges for vacuum sealing. Operations under either vacuum or differential pressure conditions will be possible. A rupture disk system will be installed with a low blow-out rating. This will insure an adequate pressure release in the event of an inadvertent overpressure.

During routine operations the lower half of the tank will remain fixed in place and only the upper tank lid removed for access to the furnace area.

A sealed yarn box will be constructed and positioned on a flange outside of the tank. The yarn box will contain the same pressure conditions that will exist in the furnace, and also will permit visual observation of the operations within the box.

All utility connections will pass through the lower tank wall.

A copper induction coil 33 inches in diameter and 41 inches high is being fabricated. It will be insulated by wrapping with fiberglass tape and impregnated with high temperature resistant varnish. Cooling coils will be located above and below the induction coil to provide for temperature gradients in the outer furnace area. The inside of the coil will be lined with alternate layers of refractory cement and fiberglass cloth. A cooling plate on the bottom of the furnace will be bolted to the coil and support the susceptor, work load and lampblack insulation. It will be possible to lift the entire furnace out of the bottom tank section. There will, however, be a certain amount of connections to be taken apart to remove the furnace.

Furnace support systems such as gas dryers, control panels, nitrogen deluge and a closed water cooling system are being pursued.

Additional operations for future considerations are as follows:

1. An automatic control device for monitoring the yarn tension.
2. Utilization of laser beam illumination to obtain a visual check on the winding operation.

3.0 FUTURE WORK

During the next three month period all fabrication components should be received and initial check-out should be underway.

LIST OF REFERENCES

1. "Development of High Temperature Resistant Materials for Use In Naval Ordnance," First Quarterly Report prepared by Atlantic Research Corporation under Contract No. N00017-73-C-4306 for Naval Ordnance Systems Command, November 15, 1972.

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13. ABSTRACT

Work continued on process scale-up to permit the fabrication of filament reinforced graphite composites in sizes up to 16-inch outer diameter. The design of the outer vacuum container was completed and the container was ordered. The design of the furnace induction coil was completed, and the coil was placed on order. The required scale-up components should be available during the next report period.

The scale-up version includes several desirable features, not available in previous fabrication equipment. These include external filament storage to permit observation of the filament feed system during fabrication, suitable view ports to permit laser beam illumination and visual observation of the fabrication process inside the furnace, and various arrangements to permit the use of the equipment for subsequent production requirements.

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