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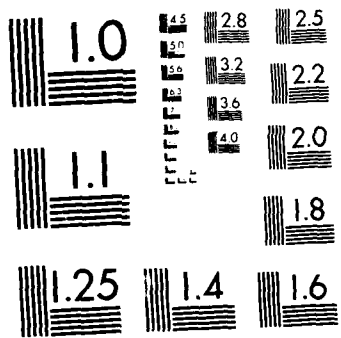
PROCESSING TECHNOLOGY RESEARCH IN COMPOSITES(U)
RENSSELAER POLYTECHNIC INST TROY NY R J DIEFENDORF
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A state-of-the-art chemical vapor deposition apparatus has been designed and built. A relatively sophisticated control program, with some AI features, is incorporated.

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INTRODUCTION

Chemical vapor deposition has been used for over fifteen years for depositing carbon matrices in carbon/carbon composites used for reentry nose-tips, rocket nozzle throat inserts, and aircraft brakes. The same technology is appropriate for depositing silicon carbide or other matrices in ceramic-ceramic composites, or ceramic/carbon composites. Furthermore, chemical vapor deposition is a powerful technique for applying the graded oxidation resistant coatings required for carbon/carbon composites in long time oxidizing environments. Modern instrumentation allows many variations in properties to be made which had been impossible in the past. It is for these reasons that we proposed the acquisition of a state-of-the-art Low Pressure Chemical Vapor Deposition Apparatus. (JFS)

EQUIPMENT DESCRIPTION

Low pressure chemical vapor deposition apparatus, with state of the art electronics, was ordered from Casey Instruments, West Sand Lake, NY. The furnace is vertically suspended from the horizontal counter surface. The power supplies and optical pyrometer are located underneath the counter, and the pumps are placed in an isolated compartment beneath the electronics.

Four feedback flow controllers are used to control up to four deposition gases in any prescribed manner. A liquid source is available also to provide a deposition gas. The

input for flow control can either be manual or from the IBMPC AT clone controller. The liquid source and associated lines were heated to allow use of condensable gases.

The furnace vacuum chamber has a uniform temperature zone of 6" diameter by 11" long and is capable of achieving 1800°C with 30 kw of power. There are three separate heaters to allow temperature uniformity. Temperature control is by an Ircon pyrometer or 3 thermocouples controlled 3 R.1. SCR Phasers. Control may either be manual or by computer. Power voltage and amperage are to be displayed. Pressure is measured by a MKS gauge and display unit. Pressure is controlled by an additional inert gas flow to the pumps. The pumps are two Welsh Model number 1374B pumps.

The system can be controlled manually or by computer. A sophisticated computer program has been written with AI features for control and operation of the furnace using dual screen displays. Finally, an appropriate warning and alarm system is part of the computer program to analyse for major malfunctions such as pump failure and low water flow.

The change in some of the components reflects the rapid improvements that are occurring in instrumentation.

LOW PRESSURE CHEMICAL VAPOR DEPOSITION APPARATUS

<u>Equipment</u>	<u>Proposed Source</u>
1. Furnace/Vacuum Chamber Usable interior zone. (0.5' Dia. x 1') Temperature (1800°C)	Casey Instruments (West Sand Lake, NY)

- | | |
|---|---|
| <p>2. Ircan Maxline Pyrometer
Temperature Controller
Micristar Manual and
Automatic Temperature
Controllers (3)
SCR Power Controllers (3)</p> | <p>Ircan
Research Incorporated

Research Incorporated
Research Incorporated</p> |
| <p>3. Power Supplies, 20 kw
5 kw
5 kw</p> | <p>General Electric</p> |
| <p>4. Vacuum Pumps (2) 1374B
Pressure Controls
(Variable Leak)</p> | <p>Welsh
MKS</p> |
| <p>5. Pressure Gauge and
Readout Model 112A</p> | <p>MKS</p> |
| <p>6. Feedback Gas Flow Con-
trollers (4)

Liquid Source Flow Con-
troller (1)
Display Model 147</p> | <p>MKS

MKS</p> |
| <p>7. Control and Data
Handling Computer
12 MHZ, 30 MB,
Hard Disk, 1 meg
memory, twin display,
1/A Board, A/D Board,
Printer</p> | <p>Tute Technology Services</p> |
| <p>8. Mass Spectrometer double
pump/interface</p> | <p>Sargent Welsh/Varian</p> |



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PROPOSED RESEARCH

The equipment will be used to develop ceramic matrix composites, and to provide samples for mechanical and environmental evaluation. Potential research areas are:

(1) SiC/SiC composites. Silicon carbide fibers have been available for over five years now. While the SiC fibers have been used to reinforce glass matrices, they have not been incorporated into a more refractory matrix. CVD

apparatus can be used to infiltrate a silicon carbide or other refractory matrix into a silicon carbide fiber preform. The matrix material can be successfully infiltrated throughout the preform and the interface between the silicon fibers and matrix controlled, so that a tough, high strength composite results.

(2) Oxidation resistant carbon/carbon composites.

Carbon/carbon composites are tough, relatively high strength materials. They have been successfully protected with coatings for use in short time, high temperature applications such as the space shuttle leading edges. Turbine parts made of carbon/carbon composites would operate at higher temperatures for longer times. New oxidation protection systems would have to be developed. Low pressure CVD is an attractive method to provide internal oxidation resistance as well as graded surface coatings.

(3) Fracture behavior of ceramic matrix composites.

Ceramic materials are many times more limited by their room temperature brittleness than their high temperature performance. The effect of fiber/matrix bonding would be studied on the fracture behavior and fracture toughness of these materials. Other toughening mechanisms would be combined in parallel if possible, to produce still higher fracture toughness in these materials.

(4) Fundamental studies in the CVD of Structural Composites. Most chemical vapor deposition technology has been developed empirically. Little is known about the mecha-

nisms of deposition and the relations among the deposition conditions, structures and properties. This had caused a great problem in the past in that every new part becomes a new project. Scaling up was performed empirically at great cost. Hopefully, this project would provide understanding and modeling required for scale-up, and apply AI for the control of experimental runs.

END

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