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**MAGNETICALLY CONTROLLED
DEPOSITION OF METALS
USING
GAS PLASMA**

**Quarterly Progress Report
January - March 1995**

Work Performed Under U.S. Department of Energy
Grant to the University of Idaho
DE-FEO7-93ID3220

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**Quarterly Progress Report
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This document reports the status of grant DE-FEO7-93ID3220 for the January-March 1995 quarter.

The objective of the grant is to develop a method of spraying materials on a substrate in a controlled manner to eliminate the waste inherent in present plating processes. The process under consideration is magnetically controlled plasma spraying. The project continues to be on schedule. The field equations have been developed and were reported in the April-June 1994 Progress Report. The equations for the external magnetic field were reported in the July-September 1994 progress report.

The field equations have been cast in a format that allows solution using Finite Element (FE) techniques. The development of the computer code that will allow evaluation of the proposed technique and design of an experiment to prove the proposed process is underway. The basic numerical technique were reported in the October-December 1995 progress report, and code development and verification are underway (see Attachment 1).

Background

Thin layers of secondary material are plated on substrates either by plating or spraying processes. Plating operations produce large amounts of hazardous liquid waste. Spraying, while one of the less waste intensive methods, produces "over spray" which is waste that is a result of uncontrolled nature of the spray stream. In many cases the over spray produces a hazardous waste.

Spray coating is a mature process with many uses. Material can be deposited utilizing spraying technology in three basic ways: "Flame spraying", direct spraying of molten metals and/or plasma spraying. This project is directed at controlling the plasma spraying process and thereby minimizing the waste generated in that process. The proposed process will utilize a standard plasma spray gun with the addition of magnetic fields to focus and control the plasma.

In order to keep development cost at a minimum, the project was organized in phases. The first and current phase involves developing an analytical model that will prove the concept and be used to design a prototype. Analyzing the process and using the analysis has the potential to generate significant hardware cost savings.

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The October-December 1994 quarterly report described the equations that were developed, the selected numerical procedure that will be used, and described the numerical formulation to be used in the computer code.

The development and check-out of the computer code is proceeding. Currently a number of "Standard Problems" are being calculated and compared to known results to assure program accuracy prior to complicating the program with the magnetic flux density and magnetic body force terms. The process of assuring accuracy, incrementally, provides a sound basis for accepting the accuracy of the program calculations when the more complex magnetically controlled plasma simulations are performed.

Attached is a list of the milestones from the grant updated to be consistent with a FY 1994 project start. The project is ahead of schedule since code development and verification (3a. & 3b.) are currently under way. However, due to the nature of applied research, the comfort of this schedule position can evaporate quickly when unforeseen difficulties arise.

Attachment 1

DE-FEO7-93ID3220
Progress Report, January-March, 1995

Phase I Tasks:

1. Formulate Equations.
 - a. Complete Literature Search. April 1994
(Complete)
 - b. Evaluate coupled MHD-Fluid dynamic equations set. April 1995
(Complete)
 - c. Perform scoping calculations. April 1995
(Complete)
2. Evaluate numerical techniques July 1995
(In Process)
3. Generate computer code and solve equations numerically.
 - a. Code Development January 1996
(In Process)
 - b. Code Verification February 1997
(In Process)