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Instrumentation for Microwave Processing

Final Report

for the period 9/1/96 to 11/30/1997

AFOSR Grant Number F496209610457

Submitted to

Air Force Office of Scientific Research

submitted by

Materials and Nuclear Engineering
College Park, MD 20742

April 2000

Instrumentation for Microwave Processing

I. Summary Statement of the Purpose and Significance of the DURIP Program

The goal of this program was to enhance our microwave processing facilities to allow us to better explore fundamental issues in microwave processing of ceramics. This grant was used to enhance our microwave processing system through the replacement of thermocouple based control to pyrometric temperature control system with a temperature capability of room temperature to 2000°C. This allowed us to minimize arcing during processing, to achieve better and more reliable temperature control, and to process at much higher heating rates. (We have recently achieved controlled heating rates of ~ 5000°C/min. It is difficult to process material in a thermocouple controlled system at heating rates much greater than 10°C/min.). An optical dilatometer system to allow closed loop intelligent process control based on sample development in addition to, or in conjunction with, temperature based control was also acquired. In addition, a centrifuge and a zeta potential analyzer were added to enhance our ability to prepare samples. Finally, the grant allowed us to purchase polishing equipment which facilitates characterization of our materials. These improvements have had a substantial impact on our ability to do research of significance to the Air Force in both the near term and the long term.

II. Summary of Achievements

As proposed, and then amended in our request for a no-cost extension of August. 1997, we purchased the following systems.

1) Automatic polishing system (including multiple specimen holders for mounted and unmounted specimens and a magnetic wheel and magnetic polishing plates for polishing cloths to facilitate the polishing process and minimize use of consumables.
2) Optical extensometer system to be used as a non-contact optical dilatomer. Includes table to facilitate focusing on sample and computer and software to allow the extensometer to be used for closed loop process control.
3) Centrifuge to allow processing of nanopowders (both consolidation of commercial nanopowders and preparation of experimental nanopowders).
4) Zeta potential analyzer to allow evaluation of size and surface charge of nanopowders. This is being used for development and dispersion of nanopowder systems.
5) Optical pyrometry system, three pyrometers on a computer controlled translation table were purchased to allow process control over at least room temperature to 2000°C. We believe that the system is capable of reliable temperature measurement and process control at higher temperatures, but we have not yet attempted to process at temperatures above 2000°C.

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13. ABSTRACT *(Maximum 200 words)*

As proposed, and then amended in our request for a no-cost extension of August 1997, we purchased the following systems: a) Amatic polishing system (including multiple specimen holders for mounted and unmounted specimens and a magnetic wheel and magnetic polishing plates for polishing cloths to facilitate the polishing process and minimize use of consumables; b) Optical extensometer system to be used as a non-contact optical dilatomer. Includes table to facilitate focusing on smaple and computer and software to allow the extensometer to be used for closed loop process control; c) Centrifuge to allow processing of nanopow (both consolidation of commercial nanopowders and preparation of experimental nanopowders); d) Zeta potential analyzer to allow evaluation of size and surface charge of nanopowders. This is being used for development and dispersion of nanopowder systems; e) Optical pyrometry system, three pyrometers on a computer controlled translation table were purchased to allow process control over at least room temperature to 2000 o C. We believe that the system is capable of reliable temperature measurement and process control at higher temperatures, but we have not yet attempted to proces at temperatures above 2000 o C.

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