Multiple Sensor Multifrequency Eddy Current Monitor for Solidification and Growth

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Recently we have developed a compact cylindrical multisensor eddy current measuring system with integral furnace to monitor II-VI crystal growth to provide interfacial information, solutal segregation and conductivities of the grown materials. The use of an array of sensors surrounding the furnace element allows one to monitor the volume of interest. Coupling these data with inverse multifrequency analysis allows radial conductivity profiles to be generated at each sensor position. At present work is going on to incorporate these outputs to control the processes within the melt volume. The standard eddy current system functions with materials whose electrical conductivities are as low as 2E2 Mhos/m. A need was seen to extend the measurement range to poorly conducting media so the unit was modified to allow measurement of materials conductivities 4 orders of magnitude lower and bulk dielectric properties. Typically these have included submicron thick films and semiinsulating GaAs. We have used this system to monitor complex heat transfer in grey bodies as well as semiconductor and metallic solidification studies. The ability to provide a multidimensional monitor of processing will be necessary for useful remote process control and understanding.
EDDY CURRENT MONITORING FOR MATERIALS PROCESSING

MULTISENSOR FURNACE CONTROLLER

1. NONCONTACT MATERIAL SENSING FOR CONTROL OF LOW THERMAL MASS FURNACE

2. LOCATING, POSITIONING FOR SIZE CONTROL, SEEDING, AND GROWTH

3. RECORD TRANSIENT PROPERTIES OF MELTING AND GROWTH

MATERIALS

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<tbody>
<tr>
<td>STEEL</td>
<td>Cu and Al</td>
<td>Silicon</td>
<td>GaAs</td>
<td>CdTe</td>
<td>Aqueous</td>
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<td>Induction</td>
<td>Alloys</td>
<td>Temp. Distr.</td>
<td>Compounding</td>
<td>HgCdTe</td>
<td>Solutions</td>
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<td>Pressing</td>
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<td>Melt Temp. Distr.</td>
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<td>Working</td>
<td>Mixing</td>
<td>Interface</td>
<td>Melt Stab.</td>
<td>Growth</td>
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<td>Phase Sep.</td>
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<td>Analysis</td>
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HARDWARE

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<tr>
<td>Sensor</td>
<td>Induction</td>
<td>Simult. Sensor</td>
<td>Frequency to 1.2 GHz</td>
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<td>Quadrature Calibration</td>
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SOFTWARE

| Computer-based data acqu. | Quadrature Relaxation | Inverse Property Analysis | Parallel Processing For Control |

358
Pull rate 3 in./hr.

Crystal 80 mm dia.

Atmospheric Argon

Water-cooled sensor 116 mm dia.

Sensor travel 25 to 125 mm above melt surface

Silicon melt - 6.5 kg (1400°C)

Silica Crucible

Graphite pedestal

Resistance Heater

203 mm
In Situ Eddy Current Analysis of Crystal Interface Shape
THM GROWTH MONITOR

SENSORS 7 TO 14

HEATER
SYCHRONOUS DUAL DETECTOR
open file ml
18 16 1989
SCAN 5
500 MHz
Testing

NACL
20 Mho/m

GaAs
Ion
Implant

Si
Liftoff
50 Mho/m 100%

open file ml
18 17 1989
SCAN 13

AHP.