UCRL CR 112526

S/C - B137209

SOFTWARE FOR X-RAY OPTICS RESEARCH INSTRUMENTATION

TECHNICAL REPORT

FINAL REPORT

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SEP 03 1993

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LARRY V. KNIGHT
MARCH 1992

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CONTRACTS
MANAGEMENT GROUP

WORK PERFORMED UNDER CONTRACT

LLNL subcontract # B137209

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TECHNICAL REPORT

FINAL REPORT, 1991

CONTRACT #B137209

Introduction

The statement of work for contract #B137209—SOFTWARE FOR X-RAY OPTICS RESEARCH INSTRUMENTATION—between The Regents of the University of California and Brigham Young University called for the implementation of computer controlled substrate motion in an existing DC magnetron sputtering system. This task entailed the design and fabrication of a vacuum compatible motor drive and substrate holder, the system had to be capable of closed loop microcomputer control which required the development of a suitable computer interface and control software. Concurrent with this task, the existing magnetron sputtering system was to be upgraded to permit ion assisted deposition. This required modification of the existing sputtering hardware to permit independent control of voltages applied to the substrate and other additional electrode assemblies. In addition to design, fabrication and installation of the system modifications a systematic study of Mo-Si multilayer coatings grown using ion assisted deposition was undertaken. These studies served, in part, as training of LLNL personnel in the ion assisted deposition technique.

Progress

The composite substrate motion assembly is illustrated in Fig 1. The design incorporates a brushless dc motor and a 4:1 reduction gear assembly housed in a light weight aluminum vacuum housing. The interior of the can is filled with one atmosphere of SF_6 and the rotary shaft motion is transmitted via a ferrofluidic rotary shaft coupling mounted in the bottom of the motor housing. An expanded view of the substrate bias assembly is shown in Fig 2. The backing plate is Be:Cu and attached to the rotary motion ferrofluidic feedthrough via a coupling shaft. The backing plate is electrically isolated from the coupling shaft with electrically insulating shims. A coin-silver ring is soldered into the back surface of the backing plate and makes electrical contact with a spring loaded brush assembly. The entire substrate stage can be electrically biased using this in-vacuum, "slip-ring" electrical contact. The substrate carriages attach to the backing plate with screw connections providing mechanical and electrical contact between the substrate holder and the backing plate.

Figure 1.
Substrate motion assembly.

Figure 2.
Substrate bias assembly.

Motor power and encoder signals are transmitted by two multi-pin mini-conflat electrical feedthroughs mounted in the motor housing. A total of 14 electrical leads are required: 6 for motor power, 3 hall effect sensors, 2 encoder leads, an index lead, +5V and electrical ground. These signals are available in the vacuum space via a 20 pin UHV compatible conflat style electrical feedthrough attached to the central rotary shaft which supports the rotating platter. Slip ring electrical contactors outside the vacuum chamber feed the signals into the vacuum space via the hollow rotary shaft feedthrough. The motor is powered using a MFM technologies linear amplifier in conjunction with a GALIL computer interface card for motor control. Substrate rotary speeds of up to 1000 rpm have been achieved concurrent with substrate electrical biases of up to 500 V_{dc}.

The system was utilized to fabricate a variety of novel ML structures. In particular ML consisting of 40 layer pairs of Mo and Si with period gradients in the range between 0.01 and 0.10 Å per layer were demonstrated. Additionally, ML structures with radially graded periods were fabricated and characterized. A study of the effects of ion assisted deposition on the structure of Mo-Si ML was undertaken for deposition pressures in the range between 1 and 10 mTorr for substrate bias voltages between 0 and -500 V_{dc}. During the course of these investigations the relevant LLNL personnel were trained in the deposition technique.

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