LIQUEFIED METAL JET PROGRAM AUTOMATION AND ROBOTICS RESEARCH INSTITUTE (ARRL)

QUARTERLY TECHNICAL REPORT

REPORTING PERIOD: 15 JULY 1993 THROUGH 15 OCTOBER 1993

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TEXAS INSTRUMENTS

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1.0 INTRODUCTION

This report covers the period from July 15, 1993 to October 15, 1993. The Quarterly Technical Reports are organized by the statement of work (SOW) listed in section 5.0 of the proposal. These are listed below.

1. Reports and demonstration
2. Equipment
3. System test and experimentation
4. Test coupon evaluation
5. Technology transfer

2.0 REPORTS AND DEMONSTRATION, SOW 5.1

The program kick-off meeting was held October 4, 1993 at Texas Instruments. All program team members were present. They represent Texas Instruments (TI) and Automation and Robotics Research Institute (ARRI). The goal of the kick-off meeting was to develop program goals and define risk reduction opportunities. These efforts will be detailed in the Requirements Document and submitted with a later Quarterly Technical Report.

3.0 EQUIPMENT, SOW 5.2

Section 3.0, Equipment, is divided by the subsystem descriptions used in the proposal.

3.1 Fluidizer, SOW 5.2.1

The fluidizer module for the LMJ system will convert the solid metal feedstock into a liquid. This includes the engineering design, fabrication, thermal management, integration, and functional testing of the fluidizer module to introduce the metal feedstock into a high temperature melt chamber. The resulting liquefied metal will be transitioned to the droplet generator for subsequent droplet formation. The fluidizer for the no lead system will be a modified design from a pervious design used for 63/37 solder which was sponsored by the State of Texas. It will be of stainless steel construction. The design and fabrication of the pot should be complete by December 31, 1994.

3.2 Droplet Generator, SOW 5.2.2

The proprietary droplet generator for the LMJ system will accept the liquefied metal from the fluidizer and provide the instability required to excite the jet stream into a repeatable droplet formation. In addition, the droplets will have a charge induced onto them by an induction plate as they break off from the jet. A signal level will be provided to the charge plate for each droplet in

order to provide deflections for pattern printing. After being charged, the droplets will continue through an electrostatic deflection field, and to impact a substrate a precise location.

A new version of the proprietary, continuous mode generator has been designed and it will be fabricated and tested off line. This is a modification of an early design which was used on a 63/37 tin lead solder system developed on an earlier research project.

3.3 Jet/Droplet Stream, SOW 5.2.3

A path for the droplets to be charged and deflected will be provided in the design of the system. The path will also provide for alternative atmospheres for experimentation. Controlling the environment was shown in previous research programs to be critical to jetting success. There will be an environmental chamber designed to provide an inert atmosphere for system and jet impact testing. This chamber design will be a modification to a previous design used on earlier research programs.

3.4 Target Chamber, SOW 5.2.4

The test coupons on which the experiments will be performed will reside in a fixture inside the controlled inert atmosphere. This chamber will provide controlled heat for coupon preheating and test instrumentation. In addition to the chamber, a precision motion control system will be utilized to position the coupon for pattern writing. A device to catch the unwanted droplets will be included in the coupon chamber.

3.5 System Control, SOW 5.2.5

System control will include all items required to control and monitor the jetting process. The system control will include personal computers, programmable logic controller, data acquisition software, CAD data, NC program interface and custom motion control programming. The system control for the no lead system is currently being designed. A test plan will be developed to evaluate the performance of the machine system control in the 2nd quarter of 1994.

4.0 SYSTEM TEST AND EXPERIMENTATION, SOW 5.3

This task consists of planning and executing all tests and experiments. The Requirements Document will identify the testing required to establish the capability of the no lead system. Applications similar to those in use in industry will be chosen to benchmark the viability of the LMJ process.