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Liquid Metal Cluster Ion Source Technology for Repair of Packaging Interconnects

November 29,1993

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SBIR-LMCIS Phase I Project 1st report

Liquid Metal Cluster Ion Source Technology for Repair of Packaging Interconnects

We have proposed the development of a direct metal etch and write (DMEW) Technology based on recently developed liquid metal cluster ion sources (LMCIS) for repair of conducting paths in polymer and ceramic systems. This technology has been shown to be capable of depositing both gold and solder at deposition rates as high as 100,000 cubic microns per second at feature resolutions of 25-100 microns. The LMCIS's advantages over competing direct write technologies, such as laser direct write and e-beam direct write, include high deposition rate no pre- or post-processing, good adhesion and almost bulk metallization resistivity. This high throughput and localized deposition capability will enable this technology to be useful in optical test and repair of multi-layer high density interconnect substrates and populated MCMs, bare die bumping, and personalization of semi-custom MCMs. The objectives of this project during phase I are to demonstrate the feasibility of this patented and proprietary direct write technology for repair of conducting paths in polymer and ceramic systems. In phase II we will develop a production worthy DMEW tool and related process technologies.

Multi-chip modules consist of a number of bare die (integrated circuits-ICs) interconnected on a high density interconnect (HDI) substrate by either wire bonding, tape automated bonding (TAB) or flip chip bonding (FCB). These offer very significant advantages over conventional packaging such as enhanced electrical, thermal, weight and size performance. But their wide spread use has been hindered by high cost, large time to market and various technical issues. We have identified and addressed the following problems limiting a vigorous growth in MCM market:

- Low yield of multi-layer HDI substrates resulting in high cost
- Unacceptably large time to market for custom designs
- Unavailability of bumped die for TAB or FCB
- Unavailability of easy-to-use repair tools for both the HDI substrates and final populated MCM.

A direct write tool can solve the above problems, and recently several tools based on laser direct write (LDW), e-beam direct write (EDW) and liquid metal ion sources (LMIS) have been developed. But all of these suffer from several serious drawbacks which have limited their use in actual practice. Some of these limitations include substrate pre-processing (such as resist or liquid precursor) and post processing, very low throughput, poor adhesion, high electrical resistivity for metallization, and inability to produce features with large aspect ratios. To the best of our knowledge, none of the above techniques can be used to repair populated substrates. LMCIS is a unique technology developed very recently which allows both localized etching of various materials and extremely high rate localized deposition of pure metals and alloys without any pre- or post- processing.

We have summarized below our phase I tasks and progress.

Task 1: LMCIS System Modifications

Task 2: Characterization and Optimization of LMCIS Etching and deposition

Task 3: Evaluate LMCIS DMEW Technology for MCM integration

Task 4: Define LMCIS DMEW Production worthy Tool Specifications

Task 5: Final Report

We have completed Task 1 of system modifications and have started on the main task of characterizing and optimizing the LMCIS apparatus for etching and deposition processes. We have acquired and installed parts of an LMCIS apparatus (Column components and vacuum chamber) previously used at Microelectronics and Computer Technology Corporation (MCC) on a new pumping system at S I Diamond Technology, Inc.. We have fabricated and installed a gold LMCIS source in the system. A motorized x-y stage of 1.5-inch travel in each direction was installed for characterizing a number of localized deposition spots under various process parameters in a single run. This stage travel is sufficient to investigate writing metal lines for feasibility studies for customization of MCM substrates. An optical zoom microscope with a magnification 40 was installed for on-line inspection of the deposited spots.

In the next report we will inform on the progress on the characterization of localized deposition spots of gold on chrome coated silicon and alumina wafers.

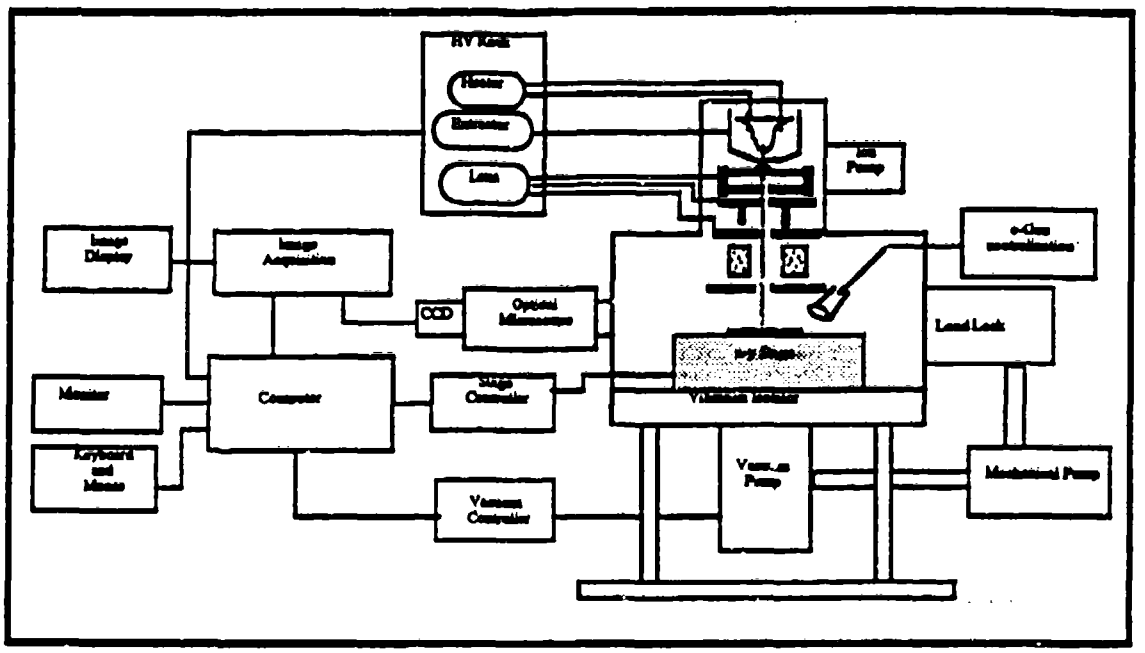

Figure 1: A schematic diagram of Direct metal etch and deposition tool using liquid metal cluster ion source technology