

Evaporation Printing™ of Microelectronics and Fine Lines on a miniLine™ for the Defense Microelectronics Activity (DMEA) and Industry

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Problem Statement

The Defense Microelectronics Activity (DMEA) serves a crucial role in overseeing the research, development, and acquisition of microelectronic components necessary for the maintenance and advancement of Department of Defense (DoD) systems. Private sector firms are often unable or unwilling to adequately respond to DoD's unique needs due to incongruous market pressures, which has underscored the necessity of high quality, cost-efficient alternative solutions to fully address strategic objectives. Current production methods under investigation include methods of "printing" microelectronic circuitry and components.

Solution Statement

Amax Innovations, the manufacturing division of Advantech US, Inc., was founded by Dr. T. Peter Brody, the inventor of the active matrix backplane. The backplane is the central nervous system driving all pixel elements for today's flat panel displays. Through decades of experience, Brody and the AMAX team believed that there should be a low cost, "elegant" solution to making complicated micro-circuitry without the capital cost and environmental impact of today's photolithography processes. To that end, Amax Innovations has developed, built, and demonstrated Evaporation Printing™, an additive process that allows for the fabrication of high quality, small size, custom microelectronic circuitry at very low cost with virtually no chemical waste in a relatively small physical footprint. Our Evaporation Printing™ process has been proven in making Active Matrix Organic Light Emitting Diode (AMOLED) and bi-stable e-Paper flat panel backplanes for these emerging display industries. These devices contain electronic circuitry including transistors, capacitors, resistors and conductor lines with feature sizes under 1 mil (25 micron) on both rigid glass and flexible polymer substrates. Additional applications under current investigation include fine conductor lines or Microlines™, embedded passive and active electronics for chip packaging and similar devices, fractal antennae, and other microelectronic devices, circuits and elements that require high precision, low cost and green manufacturing technology.



Figure 1: Amax miniLine™

Amax Innovations has recently taken this Evaporation Printing™ process technology to the next level and invested in a unique flexible inline process machine called a miniLine™ (Figure 1). The advantages of the miniLine™ include a low capital cost, small physical footprint and minimal labor requirements. This allows for a cost savings of up to 70% over incumbent technologies. The miniLine™ has been installed and is currently undergoing final commissioning, calibration and testing in our domestic and secure manufacturing facility in Pittsburgh, PA. We intend to exploit the miniLine™ as a tool for low volume and pilot production runs, a sales tool to sell equipment and license our Evaporation Printing™ technology.

Technical Concept/Narrative

At AMAX, we offer a different approach to microelectronic and fine line fabrication: a low cost alternative solution using an Evaporation Printing™ method that combines thermal and e-beam evaporation of materials through a fine metal mask or shadow mask. Shadow masks are thin metal foils having well-defined small apertures on the micron size scale allow evaporated material to be deposited onto a substrate in discrete shapes to create device features necessary for electrical circuit fabrication. Our shadow masks have pre-designed apertures of various sizes and shapes.

AMAX has improved existing shadow mask technology by developing proprietary shadow mask design, mounting, and tensioning, all of which are parts of our mask management solution. Our unique microelectronic device fabrication process consists of multiple shadow masks having different aperture arrays, in combination with a novel alignment system allowing us to fabricate microcircuits in a stepped in-line approach. Our proprietary advances to shadow mask management and alignment registration provide the opportunity to fabricate circuits containing transistors, capacitors, resistors and Microlines™. These structures can be easily fabricated on any type of rigid or flexible substrate with feature sizes under 25 microns at better than 1 micron placement accuracy without the need for conventional lithography.

To print well-defined features onto a substrate surface using our shadow masks we evaporate materials in a vacuum. Many materials (metals, oxides and semiconductors) can be evaporated using either e-beam or thermal evaporation. A key feature to evaporation is line of sight deposition in a low operating vacuum pressure that allows for structures to be fabricated that produce sharp continuous edge features. Evaporation printing through shadow masks can produce practically any device structure onto a wide variety of substrates.

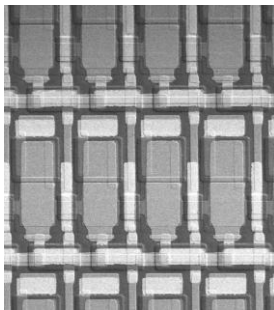


Figure 2: *A scanning electron micrograph of a completed backplane using the evaporative printing method is shown. Each sub pixel measures 83 um by*

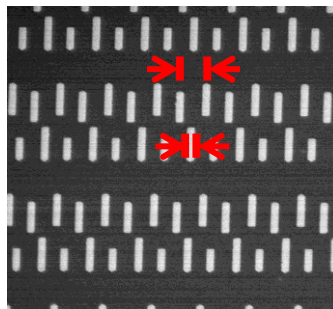


Figure 3: *A scanning electron micrograph of Microline™ segments using the Amax Evaporation Printing™ method is shown. Shown is 15 micron space with 20 micron space.*

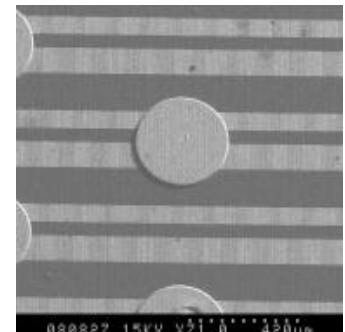


Figure 4: *A scanning electron micrograph of parallel Microlines™ connected to standard 10mil via points.*

Conclusion

In conclusion, AMAX Innovations has developed a proprietary Evaporation Printing™ process to fabricate many microelectronic devices on a flexible in-line miniLine™. Applications include active matrix display backplanes, Microlines™, Fractal Antennae Arrays, embedded electronics and a host of other devices. This is a simple, fast, low cost, efficient and green technology. Our Evaporation Printing™ equipment and technology offers the defense and the public sector a novel, new approach to making embedded electronics and conductors in the US. This capability can further facilitate the attainment of key objectives and goals of the DMEA.

