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June 12, 2001

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By Authority of the
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Ben Trella

Attorney's Docket No.: CWR 2 0290 P

PROVISIONAL APPLICATION UNDER 37 CFR 1.53(c)
TRANSMITTAL LETTER

TO THE ASSISTANT COMMISSIONER OF PATENTS
WASHINGTON, D.C. 20231

Transmitted herewith for filing is the Provisional Patent application of:

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Entitled: **INK-JET BASED METHODOLOGY FOR THE FABRICATION OF ON BOARD MICROBATTERIES FOR MICROELECTROMECHANICAL AND ELECTRONIC DEVICES**

Enclosed are:

_3_ Pages of **SPECIFICATION**

_1_ Sheet of **DRAWING** (FIGURE 1)

__ **VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS**

__ Independent Inventor

__ Small Business

__ Non-profit Organization

__ **OTHER** (Specify) _____

X A **CHECK** in the amount of $150.00 for the Provisional application Filing Fee is enclosed.

X The Commissioner is hereby authorized to charge any additional fees which may be required at any time during the prosecution of this application without specific authorization, or to credit any overpayment, to Deposit Account No. 06-0308.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government:

X No

__ Yes, the name of the U.S. Government agency and the Government contract number are:

_____

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Provisional Patent Application

INK-JET BASED METHODOLOGY FOR THE FABRICATION OF ON BOARD MICROBATTERIES FOR MICROELECTROMECHANICAL AND ELECTRONIC DEVICES

Background of the Invention

This invention pertains to the art of microelectromechanical systems (MEMS) and electronic devices, and more particularly to the art of power sources for these systems and devices. The invention is particularly applicable to a method of fabricating integrated microbatteries for MEMS and electronic devices, and will be described with particular reference thereto. It will be appreciated that the invention has broader applications evidenced in the flexibility associated with the microbatteries and their method of fabrication. For example, the method of fabrication lends itself to usefulness in the manufacturing of single larger size flat batteries.

MEMS technology provides for micron-sized complex engineering systems. MEMS integrated circuits combine logic circuitry with moving parts which enable interaction with other objects and systems. The MEMS require power to enable them to function, and such power is generally harnessed in the form of microbatteries. Existing microbatteries offer many positive attributes needed for use in conjunction with MEMS and electronic devices. Such microbatteries, however, often require separate manufacture and installation and can sometimes lead to inefficiencies associated therewith. There is a need to develop an integrated power source for microelectromechanical systems and electronic devices which provide micron-sized engineering systems. An aim in this regard is to meet the required specifications for the operation of MEMS subdevices while maintaining a minimal overall volume.

Brief Description of the Invention

In accordance with the present invention, there is provided a novel method for the fabrication of on board integrated microbatteries for electronic and microelectro-mechanical devices. This technology relies on the sequential ink-jet deposition of microdroplets of suspensions, slurries or solutions into pre-machined cavities to form the cathode, a polymer electrolyte, an anode and a metallic interconnect in a stratified-type arrangement. The microbatteries can be stacked into such cavities to yield high voltage subunits, which, in turn, can be connected either in series or in parallel to meet the demands of each and every MEMS subdevice or electronic component.

Brief Description of the Drawings

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof.

Figure 1 is a cross section schematic diagram of a battery stack of ink-jet fabricated cells in accordance with the present invention.

Detailed Description of the Preferred Embodiment

The present invention is directed to novel procedures for the fabrication of arrays of on board microbatteries. The procedures meet the required specifications for the operation of MEMS subdevices, while minimizing the overall volume. Such subdevices include, but are not limited to, motors, sensors, data storage and analysis, transmission/reception units and other ancillary functions, such as actuators involved in power and thermal management. Although the procedure for fabrication of integrated microbatteries is of rather general applicability, an example is described herein for the fabrication of lithium-ion batteries. These devices incorporate lithium ion host lattices both for the anode and the cathode in the form of μm size carbon and transition metal oxides or sulfides, respectively, and polymeric or gelled electrolytes.

Miniaturization of lithium ion batteries is achieved by ink-jet printing

techniques, in which each of the cell components (anode, electrolyte, cathode, and interconnect layers) is deposited sequentially to form the desired stratified structures as shown schematically in Figure 1. With the exception of the polymeric electrolyte, all other battery components consist of micron size particles, such as carbon for the anode, a transition metal oxide or sulfide as the cathode and a metal as the interconnect. Implementation of this methodology allows for stacks of batteries to be fabricated in cavities micromachined into existing Si or SiC wafers, which, by judicious interconnection, could supply the high voltages required for the operation of electrostatic motors and lab-on-a-chip applications. The on board integrated microbatteries can be interconnected in series or in parallel to meet the demands of virtually any MEMS subdevice or electronic component.

In order to achieve the invention, special "inks" are formulated. The inks comprise suspensions of oxides, carbon and metals that can be delivered using commercial ink-jet printer heads. Both single and stacks of batteries are produced using this methodology. Tests on performance and reliability are to be conducted. The ability to stack the microbatteries enables a reduction in interconnect resistance. The ink-jet printing methodology performs at high rates without the need of expensive equipment. The cathodes, anodes and inks utilized in forming the integrated microbatteries and the ultramicrobatteries for MEMS and electronic devices are compatible with the operation of commercial ink-jet printer heads. A piezoelectric head/nozzle assembly is used with fluids having desired or optimal rheological, hydrodynamic and other suspension fluid properties. The ink-jet printing of larger size batteries is also contemplated by this invention.

The invention has been described with reference to the preferred embodiment. Obviously modifications and alterations will occur to others upon a reading and understanding of this specification. It is intended to include all such modifications and alterations herein.

Cross sectional view

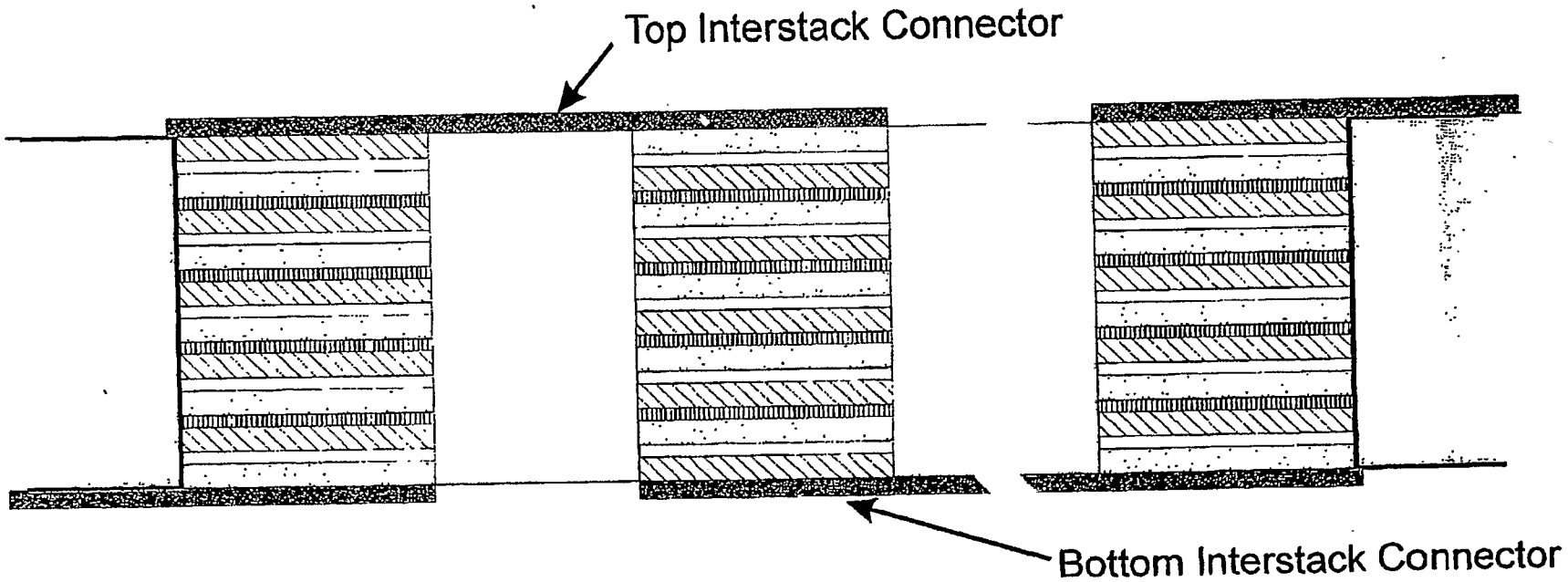

FIG. 1