3-D Folded MEMS Technology For Multi-Axis Sensor Systems

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OTHER INFORMATION

CATEGORIZED AS

- **Sensors & Instrumentation**
  - Analytical
  - Physical Measurement
  - Position sensors
  - Scientific/Research

RELATED CASES

BRIEF DESCRIPTION

A method of creating a compact assembly consisting of multiple sensors and devices.

FULL DESCRIPTION

Commonly, the approach for miniaturizing sensor/actuator systems involves using off-the-shelf components and assembling them at the PCB level into a 3D configuration. The drawbacks to this approach are that there is no path for further miniaturization, and significant assembly is required. Alignment of each device also varies after assembly of each system, resulting in signal bias errors. Another current approach is to use a chip stack with each individual die being comprised of a sensor, actuator, or IC components. This method requires independent fabrication of sensors if multi-axis sensitivities are to be used. Thermal effects are also a concern because sinking heat from the top part of the stack is very challenging. Electrical cross-talk is also a drawback due to the large density of through-silicon-bias contained in the lower parts of the stack.

UC researchers have developed a method of creating a compact assembly consisting of multiple sensors and devices. Sensors are created in parallel with a foldable microfabricated structure consisting of flexible hinges and electrical interconnects. Using this technology, complicated systems requiring multiple devices and 3D spatial configuration can be created on a chip-level. One example utilizes multiple accelerometers and gyroscopes to create a chip-level six-axis inertial measurement unit (IMU), however many other applications exist. Fabrication is done on a silicon-on-insulator (SOI) substrate, allowing for sensors to be fabricated independently of the supporting backbone. Flexible hinges and electrical interconnects are deposited around the sensors, and the folded structure is released by etching through the entire substrate. Many detection and actuation methods are compatible with this fabrication process including capacitive, piezoelectric/piezoresistive, and electrostatic techniques.

SUGGESTED USES

Any device compatible with SOI or IC fabrication techniques can be utilized on the folded structure, including but not limited to accelerometers, gyroscopes, pressure sensors, resonators, signal detection electronics and energy scavengers. One use would be that of a chip-level IMU, currently desired for navigation, exploration, robotics, and personal entertainment. Another potential use would be a 3D microphone or ultrasonic device capable of measuring or sending signals along all axes.

ADVANTAGES

The current invention utilizes wafer-level assembly and packaging, resulting in a very compact unit (less than 1cm²). By utilizing a folded 3D structure, high aspect ratio single-axis sensors are configured along independent sensitive axes. All devices are fabricated with identical techniques that reduces performance variance between devices resulting from fabrication imperfections. Additionally, by fabricating sensors in-situ with that of the folded structure, all components are lithographically aligned, minimizing output errors. Rigidity of the structure is maximized by using silicon-to-silicon welding of all sidewall edges, which also prevents thermal expansion effects because the structure is comprised of only silicon.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,368,154	02/05/2013	2010-527

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Micromachined Gyroscope Design Allowing for Both Robust Wide-Bandwidth and Precision Mode-Matched Operation
- Prioritizable IMU Array (Prio-IMU) for Enhanced Pedestrian Navigation
- Micro-glassblowing for Gyroscope Fabrication

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