

News Release

FOR IMMEDIATE RELEASE

3D printing technology for semiconductors developed reducing MEMS sensor manufacturing time

For the rapid delivery of the wide range of sensors needed for an IoT society

Tokyo, February 15, 2017 --- Hitachi, Ltd. (TSE: 6501, Hitachi) today announced the development of 3D printing technology for semiconductors that shortens the manufacturing period of MEMS⁽¹⁾ sensors that measure vibration, acceleration, etc. Conventionally, MEMS sensors have been fabricated on a mass-production basis, and the design and manufacturing could take from roughly three months up to one year⁽²⁾. In addition to the new 3D printing technology developed, artificial intelligence (AI) was applied to automate the design of sensor shape and dimensions, resulting in the design and fabrication of 100 vibration MEMS sensors within one month⁽³⁾. Hitachi will power the IoT society by quickly providing the wide variety of sensors required at various sites.

In order to monitor operating status or environment, many objects need to be sensed and thus a wide variety of sensors are required for different signals such as sound or vibration with different specifications such as frequency or sensitivity. Many of these are MEMS sensors which are micro electro mechanical systems, and in an IoT society, customers require a wide range of different sensors. MEMS sensors today however are manufactured in semiconductor lines designed for mass production, making it difficult to produce small volumes of different types of sensors quickly.

To address this need, Hitachi developed technology to rapidly design and fabricate small volumes of different types of MEMS sensors to meet the diverse sensing requirements of customers. Two main features of the technology developed are as follows:

(1) Rapid automated design technology employing AI

Drawing from Hitachi's repository of over 1 million MEMS sensor design data, designs closest to the required specification are selected and simulation is conducted to determine a sensor configuration that satisfies the required specification. Selection is based on AI based cluster analysis⁽⁴⁾, and simulation is based on the results from analyzing the correlations between configuration and performance. By automating the design process in such a way, MEMS sensors can now be quickly designed.

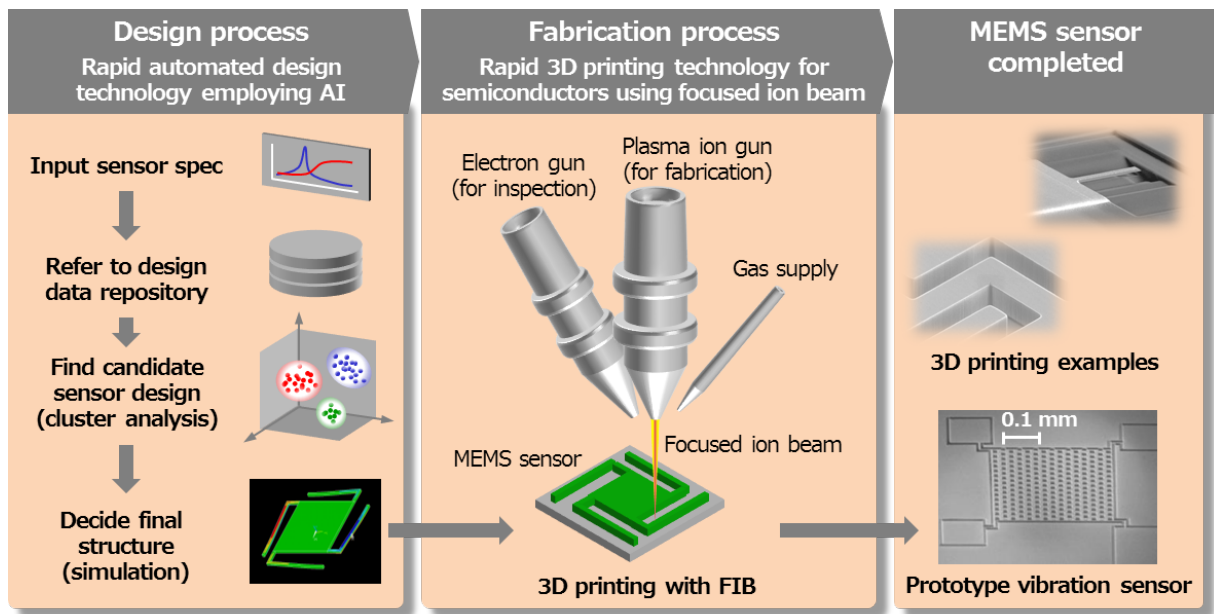
(2) Rapid 3D printing technology for semiconductors using focused ion beam

Based on the design for MEMS sensor configuration, a focused ion beam⁽⁵⁾ (FIB) of less than 1 μm (one-thousandth of one-millimeter) is applied to fabricate the MEMS structure through 3D printing. Conventional FIB equipment however is used for analysis and thus in terms of speed, application to fabricate MEMS was impractical. To overcome this speed issue, joint development was conducted with Hitachi High-Technologies Corporation and Hitachi High-Tech Science Corporation, to develop a new plasma ion source⁽⁶⁾ for the FIB equipment to realize a high output beam vastly improving fabrication speed. This development enabled the rapid manufacturing of MEMS sensors.

As an application example of these technologies, a MEMS vibration sensor was prototyped to measure high frequency signals of over 20 kHz to detect signs of malfunction in factory motors or compressors. In comparison to sensors of equivalent performance fabricated in conventional semiconductor lines, the MEMS sensor developed with the new technology was designed in 5 days and required 5 hours per sensor to fabricate; indicating that it was possible to design and manufacture 100 sensors in one month.

Hitachi will employ the technology developed to quickly provide a wide range of MEMS sensors to drive an IoT society. Further, by employing AI and big data analytics, Hitachi will pursue even more effective sensing technology together with customers in order to provide new value to society.

Part of this technology will be presented at the 16th International Nanotechnology Exhibition & Conference, to be held from 15th to 17th February 2017 at Tokyo Big Sight, Japan.



Flowchart of MEMS sensor design & fabrication with this technology

- (1) MEMS sensor: MEMS is an abbreviation for micro electro mechanical systems, a combination of mechanical and electric parts integrated on semiconductor substrates. Most acceleration sensors and microphones in smartphones are MEMS sensors.
- (2) Result of a survey by Hitachi. It takes approximately three months to fabricate MEMS sensors using conventional process. In many cases, it may also take several months to one year due to repeated optimization of design and fabrication.
- (3) Calculation based on the result of 5 days to design the vibration MEMS sensor and 5 hours to fabricate the same sensor.
- (4) Cluster analysis (clustering): A method to rapidly extract a group of objects with more similar properties from a mother group of objects composed of various properties. Cluster analysis is an unsupervised learning method in the field of machine learning in artificial intelligence.
- (5) Focused ion beam (FIB): Ion beams accelerated by an electric field and focused using electrostatic lenses. FIB can both engrave materials by beam irradiation and deposit materials by supplying sources gases in the irradiation area.
- (6) Plasma ion source: A device that extracts ions using an electric field from plasma generated by applying an electromagnetic field to an inert or reactant gas. Plasma ion sources provide ion beams with higher current density than the liquid-metal ion sources that are used for conventional FIB systems.

About Hitachi, Ltd.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges. The company's consolidated revenues for fiscal 2015 (ended March 31, 2016) totaled 10,034.3 billion yen (\$88.8 billion). The Hitachi Group is a global leader in the Social Innovation Business, and it has approximately 335,000 employees worldwide. Through collaborative creation, Hitachi is providing solutions to customers in a broad range of sectors, including Power / Energy, Industry / Distribution / Water, Urban Development, and Finance / Government & Public / Healthcare. For more information on Hitachi, please visit the company's website at <http://www.hitachi.com>.

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