

Hitachi Metals Develops 3-Axis Angular Rate Sensor Incorporating Lead-Free Piezoelectric Thin Film

Hitachi Metals, Ltd. (head office: Minato-ku, Tokyo; chairman and CEO: Kazuyuki Konishi; hereafter Hitachi Metals), and Wacoh Corporation (head office: Ageo-shi, Saitama; president: Kazuhiro Okada; hereafter Wacoh) have developed a 3-axis angular rate sensor that uses lead-free piezoelectric thin film. These lead-free angular rate sensors, which digital cameras use to detect camera shake and vehicles use for position sensing, will help preserve the global environment.

1. Background

Piezoelectric substances, which have piezoelectric properties that allow them to convert applied pressure to voltage and applied voltage to pressure, are fabricated in thin form to make piezoelectric thin films, which generally incorporate a material called lead zirconate titanate (PZT)¹.

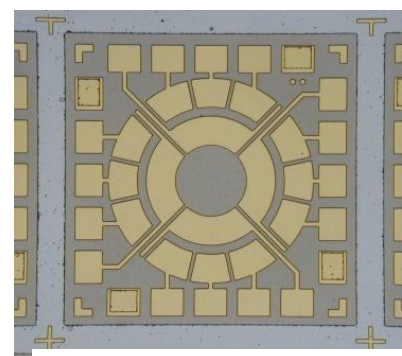
These films are currently widely used in angular rate sensors that detect digital camera shake and the position of vehicles, as well as in inkjet printer heads. Their uses are expected to expand to include micro-electromechanical system (MEMS) mirror devices² used in projectors and heads-up displays, as well as in energy harvesters³.

With the increasing awareness of the need to preserve the Earth's environment, it is necessary to eliminate the use of lead. However, it has been difficult to achieve sufficient piezoelectric properties⁴ in piezoelectric thin films using lead-free materials, and micromachining has also been difficult.

2. Overview

Hitachi Metals and Wacoh have succeeded in developing a 3-axis angular rate sensor that employs lead-free piezoelectric thin film. Potassium-sodium niobate (KNN)⁵, which is highly environment-friendly, was selected as a lead-free replacement material, and sensors incorporating it achieve the same level of angular rate sensing properties as PZT thin film sensors. During the development phase, Hitachi Metals handled the processes from piezoelectric thin film to sensor device production, while Wacoh designed the devices and evaluated the sensor's properties.

In 2010, Hitachi Cable, Ltd. (now part of Hitachi Metals) succeeded in developing lead-free KNN piezoelectric thin film with piezoelectric properties of more than 100 pm/V, which is sufficient for practical applications. This time, the elemental technologies required to manufacture angular rate sensor devices have been developed, including a thin film-making technology for six-inch wafers, a thin film-micromachining technology, and an electrode-forming technology. Based on these successes, the 3-axis angular rate sensor was developed.



3-axis angular rate sensor device

In the existing PZT thin film sensor production process, depolarization occurred when the

temperature exceeded 260°C, adversely affecting device properties. However, the newly-developed lead-free KNN piezoelectric thin film sensor has excellent temperature tolerance, and it was confirmed that its properties do not deteriorate even when the sensor is exposed to 400°C. This will enable the selection of environment-friendly soldering materials for reflow soldering processes. Hitachi Metals has established technology for mass-production and commercial use of the lead-free piezoelectric thin film wafer.

Hitachi Metals plans to present this development at PiezoMEMS 2014, an international scientific conference to be held at Kobe University's Port Island Campus on October 28 (Tue.) and 29 (Wed.) (our company's presentation number is I-8).

For inquiries from customers

Kenji Shibata, Cable Materials Company, Hitachi Metals, Ltd.
Tel: +81-29-826-7654

For inquiries from the press

Masayuki Yoshihara, Corporate Communications Office, Hitachi Metals, Ltd.
hmcc.sa@hitachi-metals.com

Wacoh Corporation

Wacoh Corporation has specialized in developing sensors since the company's founding, and has become a leader in sensor technologies, particularly for creative, groundbreaking 3-axis and other sensors used in a wide range of fields. The company is proud to be a world-class pioneer in the high-tech sector in recent years, with its 6-axis motion sensors and technologies forming essential components of next-generation mobile phone handsets and the latest robot technologies. The company has already acquired more than 240 patents in Japan, the U.S. and Europe, and will leverage these to develop additional technologies and production methods for product applications, thus widely contributing to society.

Wacoh Corporation website
<http://wacoh.co.jp/>

Glossary

- 1: Lead zirconate titanate (PZT), $\text{Pb}(\text{Zr}_x\text{Ti}_{1-x})\text{O}_3$, is a crystal with a perovskite structure.
- 2: MEMS mirrors are micro-mirror components whose angle of reflection can be modified with electric charges.
- 3: Energy harvesters (vibration power generation elements) are devices that convert pressure into electric power.
- 4: Piezoelectric properties indicate the extent of deformation when a voltage is applied to a device.
- 5: Potassium–sodium niobate (KNN), $(\text{K},\text{Na})\text{NbO}_3$, is a crystal with a perovskite structure.