

High-Density 3-D Microsystem-in-Package
Technology and its Application for Integrated CCD
Micro-Camera Visual Inspection System

Hiroshi Yamada, Takashi Togasaki*, Atsushi Sadamoto,
Hajime Sudo

Corporate Research & Development Center,
Toshiba Corporation, 1, Komukai Toshiba-cho, Saiwai-
ku, Kawasaki 212-8582, Japan

*Corporate Manufacturing Engineering Center,
Toshiba Corporation, 33, Shin-isogo-cho, Isogo-ku,
Yokohama 235-0017, Japan

High-density and high-speed electronic packaging technology is progressing rapidly and has become indispensable for realizing high-performance electronic products. Recently, in the field of high-density and high-speed packaging, microsystem-in-packaging technologies to improve MEMS performance have been reported.

The authors are doing research on a CCD micro-camera visual inspection system which consists of an experimental wireless micromachine for inspection of inner surface of 10mm ϕ tube in electronic power generators. The experimental wireless micromachine for visual inspection moves by itself while capturing the image of the inside of the tube and communicating with the external host computer at the bandwidth of 24GHz. As the CCD micro-camera system module includes the intricate rotating electrostatic actuating mirror, a large-scale optical lens for internal focusing mechanism, and many LSI devices and discrete chip components for the CCD imaging data transmission circuit, it was difficult to package all of the devices into the restricted small-diameter CCD micro-camera visual inspection system interior.

It is well known that 3-D packaging technology enhances system performance, raising it to a level that cannot be achieved by conventional planar packaging technology. However, many of the 3-D packaging technologies reported previously are designed mainly for use with homogeneous LSI devices. And the previous 3-D packaging technologies are unsuitable for use with heterogeneous LSI devices and chip components such as CCD imaging data transmission circuit. In regard to the MEMS packaging technology, the technology is not sufficiently advanced to be suitable for the high-density microelectronics systems and the packaging size occupies a large area compared with the individual MEMS devices. Accordingly, it was necessary to develop an advanced 3-D microsystem-in-packaging technology capable of realizing a CCD micro-camera visual inspection system which incorporates many kinds of electrical devices of different sizes, the complicated electromechanical system devices, and the optical components at far higher packaging density than it is possible to attain using conventional technology.

This paper describes the high-density 3-D microsystem-in-package technology and its application for an integrated CCD micro-camera visual inspection system. The CCD micro-camera visual inspection system incorporates the CCD imaging data transmission circuit as a 3-D packaging module by applying the high-density interconnection stacked unit modules and CCD viewpoint changing mechanism for inspection of inner surface of tube. The high-density stacked unit modules have fine-pitch flip-chip interconnections within Cu-column-based solder bumps and high-aspect-ratio sidewall footprint realized by Cu-filled stacked vias. The CCD viewpoint changing mechanism, which is an electromechanical system constituting of the electrostatic

actuating mirror and the internal focusing mechanism, was realized by 2 axial electrostatic wobble motors and a catadioptric lens. And, the CCD micro-camera visual inspection system, integrating all of the many kinds of electrical devices of different sizes, the electromechanical system, and optical components, was evaluated electrically to confirm the effectiveness of the 3-D microsystem-in-package technology.

Acknowledgements: This work was performed under the management of the Micromachine Center as part of the Industrial Science and Technology Frontier Program, "Research and Development of Micromachine Technology," of the Ministry of Economy, Trade and Industry of Japan, previously the Ministry of Trade and Industry supported by the New Energy and Industrial Technology Development Organization.

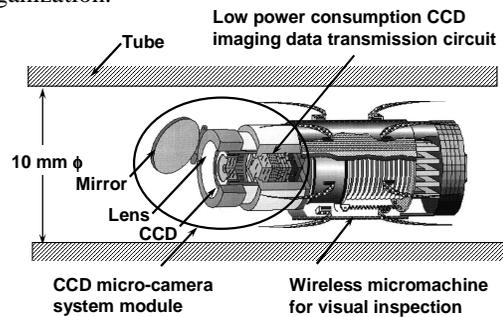


Fig. 1 Experimental wireless micromachine for inspection of inner surface of tube

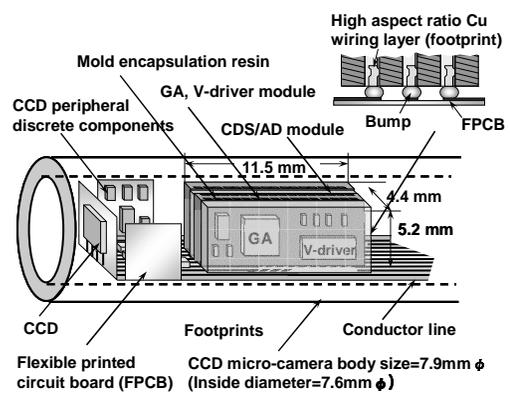


Fig. 2 High-density 3D packaging sidewall interconnection

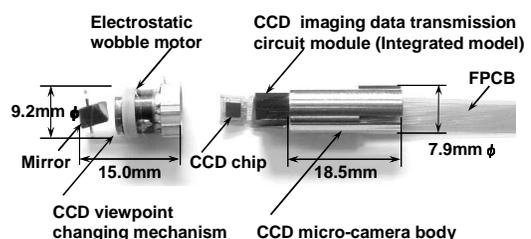


Fig. 3 Photograph of CCD micro-camera visual inspection system

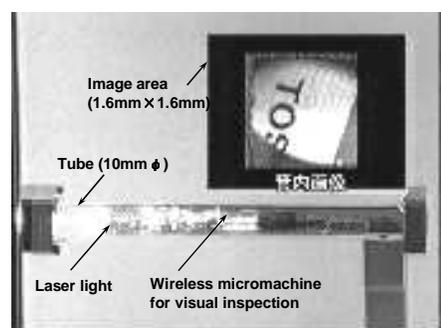


Fig. 4 Photograph of experimental wireless micromachine for inspection communicating with external host computer