

## 3D-IC Technology: Reliability Challenges and Biomedical Application

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### Abstract:

3D-IC using TSVs is one of the most promising candidates for high performance computing system since 3D-ICs have lots of advantages such as high memory bandwidth and low power consumption due to short wiring length and small pin capacitances. Until now, several kinds of 3D-ICs including 3D-memory and 3D-CIS have been fabricated successfully. However, several reliability issues still remain in 3D-ICs with TSVs. In general, there are millions of TSVs and metal microbumps in vertically-stacked thinned Si chips. Both TSVs and metal microbumps cause local mechanical stress and strain in the Si chips due to coefficient of thermal expansion (CTE) mismatch between Si and Cu TSV and metal microbump. As the thickness of Si chip is less than several tens of  $\mu\text{m}$ , both intrinsic and extrinsic gettering layers to suppress metal contaminations and crystal defects might be eliminated from the Si chip by thinning process. This paper focuses on the 3D-IC reliability issues such as thermomechanical stress and Cu contamination, and presents effective evaluation methods for the issues. Moreover, several kinds of biomedical applications using 3D-IC and 3D integration technology are briefly presented.



**Tetsu Tanaka** received the B.S. and M.S. degrees in electronics engineering and the Ph.D. degree in machine intelligence and systems engineering from Tohoku University, Sendai, Japan, in 1987, 1990, and 2003, respectively. In 1990, he joined Fujitsu Laboratories, Ltd., where he was engaged in the research and development of the highly-scaled MOSFETs including SOI devices. From 1994 to 1995, he was a Visiting Fellow with University of California, Berkeley. In 2005, he joined the Tohoku University as an Associate Professor, and became a Professor of Graduate School of Biomedical Engineering, Tohoku University in 2008. After joining Tohoku University, he is working on

the research and development of integrated biomedical micro/nano-devices and systems using 3D-IC technology and neural engineering. His current research topics include fully-implantable retinal prosthesis, intelligent Si neural probe, 3D integration technology, and analog/digital IC design. He has published more than 150 technical papers and given more than 30 invited talks. He has or had served as a technical committee member or an editor of various international conferences and journals, such as International Technology Roadmap for Semiconductors (ITRS, 2006-2016), International Interconnect Technology Conference (IITC, 2008-), International Conference on Solid State Devices and Materials (SSDM, 2008-), Symposium on VLSI Technology (2009-), International Electron Devices Meeting (IEDM, 2011-2012), and Japanese Journal of Applied Physics (JJAP, 2009-2011).