Wafer Level Vacuum Packaging For Sensors

Wan-Thai Hsu
Chief Technology Officer
Discera, Inc.
2000 Hogback Rd. Suite #12
Ann Arbor, MI 48105
U.S.A.
whsu@discera.com

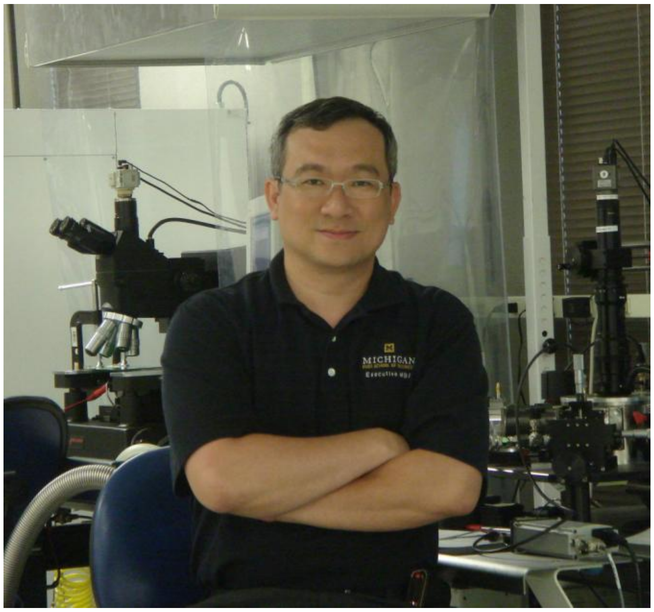
Abstract

This tutorial provides a practical matrix analysis tool for those sensor developers and researchers who want to bring their innovative designs to volume production.

In the past two decades, MEMS sensors have demonstrated much better sensitivity and reliability with much lower manufacturing cost than their macro-scale counterparts. Thanks to the progress of MEMS manufacturing, nowadays, MEMS sensors have penetrated to everyone's daily life. On the other hand, even MEMS sensors have such great market share and popularity, more and more innovative sensor designs are rolling out to the market. However, from practical point of view, it is commonly cited that packaging accounts for 80% of the cost of a MEMS device. Therefore, wafer level packaging technologies are extremely important to commercialization of innovative sensor designs.

This tutorial combined matrix analysis of various wafer level vacuum packaging technologies and different interconnection schemes. Wafer level packaging technologies include wafer bonding (include glass frit, metal eutectic, anodic, and silicon fusion bonding) as well as thin film encapsulations (epitaxial silicon, poly-silicon, dielectric, and metal). On the other hand, the interconnection technology include through silicon via (TSV) from the top and the bottom of the wafer, as well as interconnection from sideways. Pros and cons of each of the possible combinations will be discussed. A series of vacuum gauges will also be presented as an evaluation tool for characterizing wafer level vacuum packaging. The gauges include traditional cavity deflection, Parini gauge, and resonator array vacuum gauge.

Dr. Wan-Thai Hsu's Bio:



Dr. Hsu received B.S. and M.S. degrees from National Tsing-Hua University, Taiwan and Ph.D. degree from University of Michigan, all in Electrical Engineering. He is one of the pioneer researchers and inventors in the area of MEMS resonators and oscillators. Part of his doctoral work led to the birth of Discera Inc., the first MEMS oscillator company in the world in 2001.

Currently he is Chief Technology Officer at Discera. Since 2001, he has successfully led Discera making silicon MEMS oscillators from research to commercial products. The efforts include developing novel resonator structures for highly stable oscillators, wafer level vacuum packaging at 1-10 mTorr level for volume production, and sophisticated mixed-signal circuits for temperature compensation and timing applications. Silicon MEMS oscillator is now an industry with more than 10 players worldwide, targeting more than $4B annual markets. He is a frequent invited speaker in international conferences – TPC chair of IEEE Frequency Control Symposium 2012, and general chair for 2014. He holds 10 U.S. patents and has 4 patents pending.

Dr. Hsu was awarded "Innovation of the Year" in 2007 *EE Times* Annual Creativity in Electronics award. Later that year, Discera's silicon MEMS technology was honored in *Wall Street Journal* Technical Innovation Award. Other than his Ph.D., he also received Executive MBA degree from Ross Business School, University of Michigan in 2010, with focuses on entrepreneurship and innovation.