GÜLŞAH DEMİRHAN AYDIN, Assistant Prof. Dr.

Personal Information

Contact Information

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Education Information

1) **01 September 2016 - 01 September 2022**
   Doctor of Philosophy, Ph.D., MIDDLE EAST TECHNICAL UNIVERSITY, Natural and Applied Sciences, Micro and Nanotechnology, TÜRKİYE.
   Thesis Title: A Wafer Level Vacuum Packaging Technology for MEMS Based Long-Wave Infrared Sensors
   Thesis Subject: This thesis proposes a new approach to obtain wafer level vacuum packaging that satisfies the requirements of the thermal sensors at low cost and with high performance. The moth-eye structures are formed on both side of a polished flat silicon wafer without any cavity to allow the transmission of the infrared radiation in long wave infrared region (LWIR). Then, this wafer is bonded to another spacer wafer using Au-In Trans-liquid phase (TLP) approach that allows bonding at low temperature (around 200℃); the advantage of the TLP approach is that it can handle very high temperatures (such as 500℃) after the bonding is complete. This allows the use of glass frit bonding of the cap wafer stack to the sensor wafer using high temperature bonding approaches such as glass frit at around 430℃, which can activate the getter perfectly. The spacer wafer is etched using deep RIE approach to form the cavity opening of the cap wafer stack, where the getter layer is deposited using a shadow mask. This packaging approach is verified (i) by fabricating the grating structures on a double sided polished wafer and demonstrating their measured infrared transmission performance as about 85%, (ii) optimizing and verifying the TLP bonding performance of the window cap wafer and the spacer wafer, (iii) optimizing the cavity opening step without damaging the moth-eye structures, (iv) optimization of glass frit deposition and glass frit bonding for 8" size wafers, (v) developing a vacuum sensor wafer with Pirani vacuum gauges for bonding quality measurements (vi) bonding the cap wafer stack to various silicon wafers and measuring bonding quality including the vacuum level of the hermetically sealed cavity regions. The bonding quality

of the wafer level packaging approach is measured with three different approaches: He-leak tests, cap deflection, and pirani vacuum gauges. The bonds formed with the offered method were tested hermetic via He-leak tests performed according to MIL-STD 883. For the polished wafer usage case, the average shear strength obtained with the offered wafer level bonding method is 23.38 MPa and He-leak values as low as 0.1x10- 9 atm.cc/sec were obtained. For the grinded wafer usage case, the average shear strength obtained with the offered wafer level bonding method is 18.72 MPa and He-leak values as around 1x10-8 atm.cc/sec were obtained. Best package pressure is measured around 3-4 Torr if getter is not used whereas in the case of getter usage best pressures ranging from 1 mTorr to 500 mTorr are measured. Keywords: MEMS, Wafer Level Vacuum Packaging, Hermetic Encapsulation, TLP Bonding, Glass Frit Bonding, Thermal Infrared Detectors.
Date: 2022
Thesis Advisor: Prof. Dr. TAYFUN AKIN
Thesis Co-Advisor: Prof. Dr. YUNUS EREN KALAY
Diploma Number: 152552

2) **04 February 2013 - 05 February 2016**
Master's Thesis, M.Sc. MIDDLE EAST TECHNICAL UNIVERSITY, Natural and Applied Sciences, Electrical and Electronics Engineering Department, TÜRKİYE.
Diploma Number: 123232
Cumulative Grade Point Average: 3.0 / 4.0 24

3) **03 September 2007- 06 June 2012**
Bachelors, ATILIM UNIVERSITY, Mechatronics Engineering Department, TÜRKİYE
Diploma Number: 913
Cumulative Grade Point Average: 3.68 / 4.0

4) **24 September 2007- 04 June 2012**
Bachelors, ANADOLU UNIVERSITY, Business Administration, B.S., Türkiye
Diploma Number: 2012-32262
Cumulative Grade Point Average: 65.42 / 100.0

Experience Information

1) February 2024- Now (Full Time) Assistant Prof. Dr., BAŞKENT UNIVERSITY, ENGINEERING FACULTY, ELECTRIC AND ELECTRONICS ENGINEERING DEPARTMENT.
2) February 2023- Now (Part Time) Instructor Dr., ATILIM UNIVERSITY, ENGINEERING FACULTY, MECHATRONICS ENGINEERING DEPARTMENT.
3) November 2017- November 2017 (1 Week) (Full Time) VISITING RESEARCHER, THE INSTITUTE OF MICROELECTRONICS OF BARCELONA (IMB-CNM).
4) August 2012- January 2024 (12 Year) (Full Time) SENIOR RESEARCHER, METU MEMS CENTER

Scientific Technological Activity Field

Research Interests

1 Micro Electro Mechanic Systems (MEMS)

2 Mechatronic Systems

3 Wafer Level Packaging (WLP)

4 3D System Integration

5 Microbolometers

6 Inertial Measurement Unit (IMU)

7 Test and Characterization of MEMS based sensors

8 Control Systems

PUBLICATIONS

Journals

1. Y. Arslan, G. Demirhan Aydın, D. Karaçor, and N. Akgün "Geçmişten Günümüze Gaz Basınç Sensörleri Piezorezistif Sensörler Üzerine Bir Derleme," Gazi University Journal of Science (Art, Humanities, Design and Planning), 13(3), 2025.

2. M. Erbaş and G. Demirhan Aydin "Review of GPS and IMU System Performance in Unmanned Aerial Vehicles (UAVs)," ALKU Journal of Science 2025, 7(1), 2025.

3. G. Demirhan Aydin, O.S. Akar, T. Akin, "Wafer Level Vacuum Packaging of MEMS-Based Uncooled Infrared Sensors," Micromachines, 15(8):935, July 2024. https://doi.org/10.3390/mi15080935
4. G. Demirhan Aydin and T. Akin, "Resonance-Based Temperature Sensors using a Wafer Level Vacuum Packaged SOI MEMS Process," Adv. Mater. Lett., 11 (1), 20011462 (1-8), Jan. 2020. http://dx.doi.org/10.5185/amlett.2020.011462

International/National Conferences

1. G. Demirhan Aydin, "Micro Revolution in Defense Technologies: The Significance and Powerful Applications of MEMS," *6TH INTERNATIONAL ENGINEERING AND TECHNOLOGY MANAGEMENT SUMMIT*, 18.10.2024.

2. G. Demirhan Aydin, A. Günay, M. Küçükosmanoğlu, "Otonom Traktörlerin Engellerden Güvenle Kaçınmasını Sağlayan Oransal Kontrolcü Tabanlı Algoritma," *2024 Innovations in Intelligent Systems and Applications Conference (ASYU)*, 16.10.2024.

3. G. D. Aydın, A. B. Aydemir, M. T. Kansou and K. O. Altınuç, "A New Approach for Addressing Slip Ratio Optimization and Trajectory Tracking Challenges in Autonomous Tractor Operations," *2024 32nd Signal Processing and Communications Applications Conference (SIU)*, Mersin, Turkiye, 2024, pp. 1-4, doi: 10.1109/SIU61531.2024.10600918.
4. G. D. Aydın, D. Doğan and Y. T. Türken, "Lyapunov-based Controller Design for Precise Monitoring, Speed Control and Trajectory Planning in Autonomous Tractors with Trailers," 2024 32nd Signal Processing and Communications Applications Conference (SIU), Mersin, Turkiye, 2024, pp. 1-4, doi: 10.1109/SIU61531.2024.10600765.
5. G. D. Aydin and S. Ozer, "Infrared Detection Technologies in Smart Agriculture: A Review," 2023 International Aegean Conference on Electrical Machines and Power Electronics (ACEMP) C 2023 International Conference on Optimization of Electrical and Electronic Equipment (OPTIM), Istanbul, Turkiye, 2023, pp. 1-8, doi: 10.1109/ACEMP-OPTIM57845.2023.10287033.
6. Gülşah Demirhan Aydın, Tayfun Akın, Resonance-Based Temperature Sensors using a

Wafer Level Vacuum Packaged SOI MEMS Process, 30th Asian Advanced Materials Congress, 31 October - 4 November 2019, Singapore, pp. 65-66.

7. 2. Gülşah Demirhan, Kağan Güney, Burak, Telek, S. Betül Coşkunoğlu, Zeynep Kayı, Bülent İrfanoğlu, Optical Flow, 3. Mekatronik Mühendisliği Öğrenci Kongresi (MeMÖK 2012), Atılım Üniversitesi, Ankara, pp. 15-24, 8 June 2012. ISBN 9789756707364

PROJECTS

1 Project Title: Hava ve Uzay Platformlarına Yönelik Yüksek Basınç ve Hassasiyette Çalışabilen, Askeri Standartlara Uygun Basınç Sensörünün Geliştirilmesi Project Duration: 01.11.2024-recent) Academic Advisor

2 Project Title: LADES (Çip Komplesi Üretim Prosesi Geliştirilmesi ve Prototip Üretimi) Projesi (ODTÜ MEMS Merkezi-ROKETSAN Roket Sanayii ve Tic. A.Ş.) Project Duration: 08.08.2022-08.11.2023 Project Manager

3 Project Title: OrChESTRA (Organ-on-a-Chip Focused Strategic Partnership) Call: HORIZON-WIDERA-2021 Area: WIDERA-Twinning Project nb.: 101079473 Project Duration: 01.09.2022-31.08.2025 Researcher (till the 2023 January)

4 Project Title: MİKROBOLOMETRE KIZILÖTESİ DEDEKTÖR TAKIMI GELİŞTİRİLMESİ PROJESİ Supported by: T.C. Cumhurbaşkanlığı Savunma Sanayii Başkanlığı Project Duration: 12.12.2019-05.05.2022 Researcher

5 Project Title: METU MEMS Center Internal Project Development (Wafer Level Vacuum Packaging, Microbolometers, Pirani Vacuum Sensors, RF MEMS) Supported by: METU MEMS Center Project Duration: January 2017- January 2024 Researcher

6 Project Title: TOPAZ (MEMS based Gyroscope development) Supported by: T.C. Cumhurbaşkanlığı Savunma Sanayii Başkanlığı Project Duration: August 2012-December 2016 Researcher

7 Project Title: TURKUAZ (MEMS based Gyroscope development) Supported by: T.C. Cumhurbaşkanlığı Savunma Sanayii Başkanlığı Project Duration: August 2012-September 2015 Researcher