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Opto-Electro-Mechanical Components and System Reliability Analysis Lab

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A. Introduction

The Opto-Electro-Mechanical Components and System Reliability Analysis Lab was found in 2006 by the Dr. Kuan-Jung (Kenny) Chung. He and his research group focus on the package design and reliability analysis of materials, components, and system, with applications in energy, microelectronics, optoelelectronics, sensing and nanotechnology.

B. Research Field

1. **Advanced Packaging:** System-in-Packaging (SiP), and Packaging-on-Package (POP) design, mechanical stress/thermal/reliability analysis (simulation).
2. **Mechanical Property Characterization:** mechanical testing and stress simulation of thin/thick film, bulk materials for opto-electro-mechanical components and system.
3. **Piezoelectric Device Development:** piezoelectric sensor for vacuum measurement and flexible piezoelectric device (collaborated with Professor Wu's Team in NCHU), Surface Acoustic Wave (SAW)-based device for RFIDs and RF electricity generator.
4. **Degradation of the Li-ion Batteries:** degradation modeling and accelerated testing, optimal charging control, diagnostics of batteries, State of Health (SOH) assessment.
5. **Other topics:** design (simulation), packaging, and reliability testing for opto-electro-mechanical or biochemical-electrical components and system.

C. Test and Simulation Service

The Lab provides the multidiscipline tests to precisely evaluate the whole performance and reliability of components or system using the premium facilities and simulation tools in the lab and other collaborated research institutes at the university and industry respectively.

1. Reliability Testing Facilities

Equipment Name	Company /Model	Specifications	Test Items	NO.	Remark
Environ-mental Test Chambers	Thermotron SE-300-6-6 (USA)	Temp Range: -70~180 ℃ Humidity Range: 10~98% RH Temp Change Rate: 7~10 ℃/min Inner Chamber Dimension: 300L (W61×H71×D67 cm)	Temp/Humid Cycling, Thermal Cycling, High/Low Temp Storage Tests, Accelerated-level Tests.	1	Compatible with most of the Industry Test Standards (Electronics,
	Espec Pl-3KPH (Japan)	Temp Range: -40~150℃ Humidity Range: 20~98%RH Inner Chamber Dimension: 408L	Temp/Humid Cycling, Thermal Cycling,	1	

		(W60×H85×D80 cm)	High/Low Temp Storage Tests, Accelerated-level Tests.		LEDs, Opto-Electro -Mechanical Modules, etc.)
	MHU-408ASA (Taiwan)	Temp Range: -40~150℃ Humidity Range: 10~98%RH Inner Chamber Dimension: 408L (W60×H85×D80 cm)	Temp/Humid Cycling, Thermal Cycling, High/Low Temp Storage Tests, Accelerated-level Tests.	1	
	Giant Force GTH-408 (Taiwan)	Temp Range: -60~100℃ Humidity Range: 10~98% RH Inner Chamber Dimension: 408L (W60×H85×D80 cm)	Temp/Humid Cycling, Thermal Cycling, High/Low Temp Storage Tests, Accelerated-level Tests.	1	
Battery Testing System	Jiehan BTS-3030-3 (Taiwan)	Multichannel: 3 channels Programming Charging/ Discharging Profiles Output Load: +/- 30V, +/- 3A Voltage/Currents On-time Monitoring [a]		2	[a]: with Data Acquisition Module

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2. Supporting Measurement Facilities

Instruments					
Equipment Name	**Company /Model**	**Specifications**	**Test Functions**	**No.**	**Remark**
Function Generator	HP 8165A (Germany)	1mHz~50MHz	Generate Different Types of Electrical Waveforms	1	
DC Power Supply	Matsusada PR-200-37-LHIs (Japan)	200V/37A (7500W) Output Rate Control (Adjustable)	Supply Different DC Power	1	High Current Output Model for Accelerated Life/limitation Tests
DC Power Supply	Matsusada HAR-3N400-IH (Japan)	3 kV/400 mA (1200W) Output Rate Control (Adjustable)	Supply Different DC Power	1	High Voltage Output Model for Accelerated Life/limitation Tests

DC Power Supply	Twintex TP-2305 (Taiwan)	30V/5A Output Rate Control (Adjustable)	Supply Different DC Power	1	
Oscilloscope	Agilent S4622D (USA)	100MHz, 200MSa/s	Signal Measurement (e.g., Voltage vs. Time)	1	
Digital Multimeter	Agilent 34401A (USA)	6 1/2 Digit Portable	Voltage, Current, and Resistance Measurement	1	Continuity and Diode Test Function
Datalogger Multimeter	TES TES-2732 (Taiwan)	RS-232Interface 3 1/2 Digit Portable	Voltage, Current, and Resistance Measurement	2	Communicate with PC (e.g., Lab View) to perform on-line/time Measurement/Monitor
DC Loads Power Supplies	Kikusui PLZ1003WH (Japan)	5~500V/ 50A (1000W)	1.Characteristic or Lifetime tests of Various DC voltage sources 2. Burn in loads.	2	Applications: such as switching power supplies, primary and secondary batteries
Mobile Temperature Recorders	Yokogawa MV100/ DX100	Multi Channel Portable Data Acquisition	Measure/Monitor different Temps at various Points	2	On-line/Time Measurement
Data Acquisition Module	NI USB 6259 (USA)	16-Bit, Sampling Rate: 1.25 MS/s, USB interface	Multifunction to handle the different Signals by physical Measurements	1	Communicate with NI Lab View to perform on-line/time Measurement/Monitor
	Jiehan DAS-5020 (Taiwan)	16-Bit, 8 Channels RS232 / RS485 or USB interface		2	
Software					
Reliability Analysis	Reliasoft Weibull++7 (USA)	Different Statistic Distributions, Different Types of Test Data Input	Statistical Analysis of Test Data	1	Professional Version
	Reliasoft ALTA 7 (USA)	Different ALT, ADT Models Different Types of Test Data Input	ALT. ADT Data Analysis	1	Professional Version
Multiphysics Simulation	Comsol Whole Module			1	Version 3.4

	(Sweden)	Electrical, Mechanical, Fluid, and Chemical Modules	Multiphysics Analysis for Products		
	ANSYS (USA)			1	Collaborate with Prof. Chia-Che Wu's , and Jerry Min Chen's Research Teams[1]
Data Acquisition	NI Lab View (USA)	Signal Control Data Analysis	Signal Monitoring, Data Storage and Analysis	1	

[1] Both of their research teams are in the dept of mechanical engineering, National Chung-Hsin University, Taichung, Taiwan.

3. Failure Analysis Facilities

Equipment Name	Company /Model	Specifications	Test Functions	No.	Remark
Sample Cutting Machine	Topper CL40 (Taiwan)	Various Cutting Speeds	Cutting Samples	1	
Sample Grinding Machine	Topper P20F-1 (Taiwan)	Various Rotating Speeds with the Lubrication Module	Sample Grinding and Polishing	1	
Optical Microscope	Olympus BX51M (Japan)	Max. 1000x Optical Magnification (Connect to PC-based Image Measurement System)	Sample Observation	1	1. Medium Magnification Observation 2. TS-Link Advanced Image Measurement System
Stereo Microscope 1	Nikon SMZ-1B (Japan)	Magnification: 8~35x Working Distance: 100 mm	Sample Observation	1	Low Magnification Observation
Stereo Microscope 2	Self-Assembly (Taiwan)	CCD Zoom in/out (Connect to PC-based Image Measurement System)	Sample Observation	1	1. Low Magnification Observation 2. TS-Link Advanced Image Measurement System

Note: the advanced failure analysis using the premium instruments such as SEM, FE-SEM, FIB/SEM, X-ray, etc., can be performed by the collaborated instrument centers located within many universities that sponsored by National Science Council, Taiwan. The cost of using these facilities in these collaborated centers is cheaper than the outsource labs outside campus.

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4. Mechanical Property Characterized Facilities

Equipment Name	Company /Model	Specifications	Test Functions	No.	Remark
Universal Testing Machine	Hung Ta HT-9102B (Taiwan)	Max. Load: 5000 Kgf Max. Distance: 60 mm Max. Speed: 100mm/min	Tension, Compression, and Bending Tests	1	Extra Tools Needed for Some Tests
Microforce Testing Machine	MTS Tytron 250 (USA)	Max. Load： +/- 250 N Max. Distance： +/- 50 mm	Tension, Compression, Bending, Fatigue, and Creep Tests.	1	Extra Tools Needed for Some Tests

5. Others

Equipment Name	Company /Model	Specifications	Test /Process Functions	No.	Remark
UV Curing Machine	Self-Assembly (Taiwan)	UV Source: Panasonic Aicure ANUP5024 (Power Density: 4 W/cm^2@10 mm curing distance; 2.3 W/cm^2@15 mm curing distance) 3-axis Precision Positioning and Moving (+/- 0.1 um) with Temperature Plate Design Working Area: 5 cm x 5 cm	UV Curing	1	Temperature Monitoring Available
Dispensing Machine	Self-Assembly (Taiwan)	3-axis Precision Positioning and Moving (+/- 0.1 um) Working Area: 5 cm x 5 cm	Dispensing	1	Advanced IC Packages, and LEDs.

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6. Pictures of Selected Facilities

<table>
<tr><th colspan="2">Mechanical Tests and Failure Analysis</th></tr>
<tr><td>Universal Test Machine</td><td>Microforce Test Machine</td></tr>
<tr><td>

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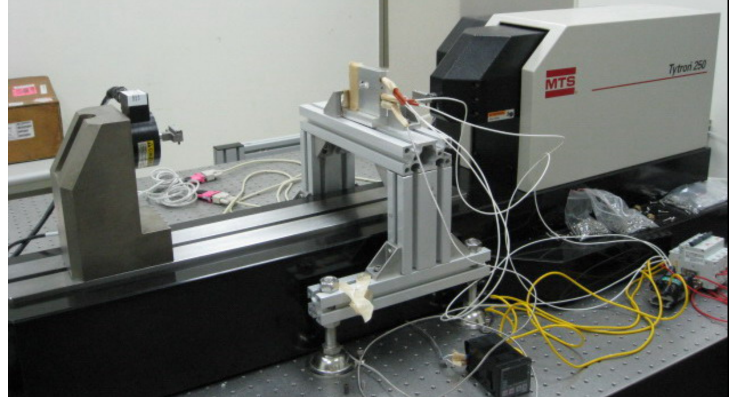

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<tr><td>Cutting Machine</td><td>Grinding & Polishing Machine</td></tr>
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Stereo Microscope	Optical Microscope(with Image Measurement System)

Reliability Test Facilities and Supporting Instruments

Environmental Test Chamber 1	Environmental Test Chamber 2

Electrical Instruments

DC Power Supply

Battery Test System

Other Facilities

UV Curing Machine

Dispensing Machine

D. People

1. Current members

a. Faculty: Dr. **Kuan-Jung (Kenny) Chung**,

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Brief Bio: **Kuan-Jung Chung** received the B.S. and M.S. degrees in Mechanical Engineering from the Tamkang University and National Yunlin University of Science & Technology (Taiwan) in 1994 and 1997 respectively. He worked in Siliconware Corporation (SPIL group), Hsin-Chu Science-Based Industrial Park (Taiwan), as a senior IC packaging engineer from 1997 to 1999. His main responsibilities included to qualify IC packaging processes and failure analysis for new products. In 2005, he received the Ph.D degree in Mechanical Engineering from the University of Maryland at College Park (major: Reliability Engineering). His research work focused on laser processing IC interconnects, finite element modeling laser process, package design, as well as reliability assessment. Before he jointed the current job in university, he worked in Dell as an advisor to help the reliability assessment program of laptop products. Now he is an assistant professor at the Mechatronics Engineering Department in the National Changhua University of Education (Taiwan). His research interests are product reliability assessment, physics of failure analysis and modeling, laser processing materials, microelectronic packaging, and prognostics and health management. He also works extensively with several industries on projects regarding the reliability analysis of microelectronic products, automobile electronics, batteries, and machines.

b. Graduate Students: 1 Ph. D student, and 9 master students.

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F. Publications (only list papers in English)

F-1. Journal Papers

1. Chia-Che Wu, Chun-Hung Hsueh, Ya-Ting Chang, Chueh-Tang Chang, and **Kuan-Jung Chung**," **A Patterning Technique of Lead Zirconate Titanate Thin Film by Ultraviolet-light**," *Microsystem Technologies*, In press, 2013. (SCI, IF=0.931)
2. **Kuan-Jung Chung**, C.F. Lin, and W.C. Chiang, "**Mechanical behavior of copper thin films subjected to various strain rate loadings**," *The Transactions of The Canadian Society for Mechanical Engineering*, accepted, to appear in vol.37, 2013. (SCI, IF=0.188)
3. **Kuan-Jung Chung**, Martin Peckerar, Joseph B. Bernstein, "**Design Optimization of Laser-Induced Microbridges for Low Resistance Interline Connections in ICs," Microelectronic Engineering**, Vol. 103, pp. 70-75, 2013. (SCI, IF=1.557)
4. **Kuan-Jung Chung**, C.F. Lin, and W.C. Chiang, " **Effect of Strain Rates on the Mecha- nical Behavior of Cu Thin Films of Various Thicknesses**," *Applied Mechanics and Materials*, Vol. 284, pp 94-97, 2013. (EI)
5. Taco Chen, Ming-Tzer Lin, and **Kuan-Jung Chung**," **Linear Energy Control of Laser Drilling and Its Application in The Repair of TFT-LCD Bright Pixels**," *Microsystem Technologies*, Vol.18, No. 11, pp 1909-1915, 2012. (SCI, IF=0.931)
6. **Kuan-Jung Chung**, and J. B. Bernstein," **Experimental Investigation of the Optimal Laser-Induced Microbridges**, " *Precision Engineering*, Vol.34, No. 3, pp. 578-585, Jul. 2010. (SCI, IF=1.167)
7. C.-J. Tong, Y.-C. Cheng, M.-T. Lin, **Kuan-Jung Chung**, J.-S. Hsu, and C.-L. Wu, " **Optical Micro-peddle Beam Deflection Measurement for electrostatic mechanical testing of Nano-scale Thin Film Application to MEMS**," *Microsystem Technologies*, Vol.16, No.7, pp.1131-1137, Jul. 2010. (SCI, IF=0.931)
8. **Kuan-Jung Chung**, J. B. Bernstein, and L. Yang, "**Experimental Study of EFO Ward Electrode Wear and Surface Pollution in Wire Bonding Process**," *Tamkang Journal of Science and Engineering*, Vol. 6, No. 1, pp. 43-48, Mar. 2003. (EI)
9. L. Yang, J. B. Bernstein, and **K. Chung**, "**The Impact of Lead-Free Soldering on Electronic Packages**," *Microelectronic International*, Vol. 18, No.3, pp. 20-26, 2001. (SCI, IF=0.471)
10. Sy-Wei Lo and **K. Chung**, "**The Optimum Condition of Manufacturing a Smooth Engineered Surface Using the Internal – Ironing Process**," *STLE Tribology Trans*, Vol. 41, No. 4, pp. 563~571. Oct. 1998. (SCI, IF=0.578)

F-2. International Conference Papers

1. Yu-Chang Lin, Kuan-Jung Chung, Chueh-Chien Hsiao, and Hsuan-Fu Wang " **A**

Novel Double Dynamic Stress Accelerated Degradation Test to Evaluate Power Fade of Batteries for Electric Vehicles," *The 1st International Conference on Intelligent Technologies and Engineering Systems (ICITES 2012)*, Changhua, Taiwan , Dec. 13-15, 2012.

2. **K. J. Chung**, C. F. Lin, W. C. Chiang, "**Effect of Strain Rates on the Mechanical Behavior of Cu Thin Films of Various Thicknesses**," *The 2nd International Conference on Engineering and Technology Innovation*, Kaohsiung, Taiwan, Nov. 2-6, 2012.
3. **Kuan-Jung Chung**, Shiau-Shiun Lin, Chih-Cheng Chen, and Sen-Chou Tsai," **Reliability Tests of a RFID-Based Lock for Power Meter Applications,"** *Proceedings of IEEE 2012 International Symposium on Computer, Consumer, and Control*, pp.945-948, 2012. (EI)
4. Chueh-Chien Shiao, and **Kuan-Jung Chung**, **"Accelerated Degradation Assessment of 18650 Li-ion Batteries,"** *Proceedings of IEEE 2012 International Symposium on Computer, Consumer, and Control*, pp.930-933, 2012. (EI)
5. **Kuan-Jung Chung**, Chih-Hao Tseng, and LiYu Yang," **The Solder Joint Reliability Assessment of a Wafer Level CSP Package**, *The 6th International Microsystems, Packaging, Assembly and Circuits Technology (IMPACT) Conference, and SIPO International 3D IC Conference,* Oct. 2011. (EI)
6. **Kuan-Jung Chung**, Liyu Yang, Bing-Yu Wang, and Chia-Che Wu," **The Investigation of Modified Norris-Landzberg Acceleration Models for Reliability Assessment of Ball Grid Array Packages,"** *The 5th International Microsystems, Packaging, Assembly and Circuits Technology (IMPACT) Conference, and SIPO International 3D IC Conference,* Oct. 2010. (EI)
7. Ming-Tzer Lin, Chi-Jia Tong, Ya-Chi Cheng, **Kuan-Jung Chung**, and Jiong-Shiun Hsu," **Measure the Mechanical Behavior of Thin Films Using Four Step Phase-Shifting Methods on the Novel Paddle Cantilever Beam Source,"** *Proceedings of Society for Experimental Mechanics - SEM Annual Conference and Exposition on Experimental and Applied Mechanics 2009*, v 4, pp. 2387-2393, 2009. (EI)
8. Ming-Tzer Lin, Chi-Jia Tong, Ya-Chi Cheng, **Kuan-Jung Chung**, and Jiong-Shiun Hsu," **Mechanical Properties Study of Nano-Scale Thin Films on the Novel Paddle Cantilever Using Optical Interferometer with Four Step Phase-Shifting Method,"** *Proceedings of DTIP of MEMS and MOEMS - Symposium on Design, Test, Integration and Packaging of MEMS/MOEMS*, pp. 140-144, 2009. (EI)
9. Yan-Ting Chen, **Kuan-Jung Chung**, and Ming-Tzer Lin, **"Mechanical Property Measurement of Nano-Scale Argentum Films on the Novel Paddle Cantilever Beams Using Four Step Phase-Shifting Method,"** *Proceedings of IEEE International Conference on Electronics Materials and Packaging (EMAP'08) - the*

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3rd International Microsystems, Packaging, Assembly and Circuits Technology (IMPACT) Conference and the 10th International Conference on Electronics Materials and Packaging (EMAP), pp.179-182, 2008. (EI)

10. **Kuan-Jung Chung**, Kuo-Jung Tseng, Siao-Syun Lin, Nikita Liao, and Ken-Yuan Lin, **"Development and Verification of Accelerated Life Test Circuits for Tire Pressure Monitoring System,"** *Proceedings of IEEE 2008 Workshop on Accelerated Stress Testing and Reliability*, 2008.
11. C.-J. Tong, M-T. Lin, Y.-T. Chen, **Kuan-Jung Chung**, and J.-S. Hsu, **"Novel Mechanical Properties Measurement of Thin Films Using Paddle Cantilever Deflection,"** *ThinFilms 2008 and NanoMan 2008*, 13-16 July, 2008, Singapore.
12. Chi-Feng Lin, Po-Hua Yang, and **Kuan-Jung Chung**, **"Design of Hybrid Solar Concentrator,"** *International Symposium on Solar Cell Technologies,* Dec. 5-6, 2008, Taipei, Taiwan.
13. **Kuan-Jung Chung**, Joseph B. Bernstein, JI Luo, J. Ari Tuchman, and Zheng K. Ma, **"Experimental Study for Low Resistance Interline Connections Using Pulsed Laser Techniques,"** *Proceedings of Quantum Electronics and Laser Science Conference (QELS'05)*, v 3, pp. 1564-1566, 2005. (EI)
14. Ji Luo, Joseph B. Bernstein, J. Ari Tuchman, Hu Huang, **Kuan-Jung Chung**, and Anthony L. Wilson, **"A High Performance Radiation-Hard Field Programmable Analog Array,"** *Proceedings of the 5th International Symposium on Quality Electronic Design, ISQUED 2004*, pp. 522-527, 2004. (EI)
15. Anthony L. Wilson, J. Luo, J. B. Bernstein, J. A. Tuchman, Hu Huang, and **Kuan-Jung Chung**," **A Continuous-Time Laser Programmable Analog Array for Radiation Environments,"** 7th *Annual Mil/Aerospace Applications of Programmable Logic Devices International Conference (MAPLD),* Sep. 8-10, 2004, Washington D. C., USA.
16. Ji Luo, **Kuan-Jung Chung**, Hu Huang, and J. B. Bernstein, **"Temperature Dependence of R(on,sp) in Silicon Carbide and GaAs Schottky Diodes,"** *Annual Proceedings of IEEE International Reliability Physics Symposium,* pp. 425-426, 2002. (EI)
17. Ji Luo, **Kuan-Jung Chung**, Hu Huang, and J. B. Bernstein, **"Comparison Silicon Carbide Schottky Diodes,"** *Proceedings of 2001 IEEE GaAs Reliability Workshop*, pp.13-14, 2001. (EI)