Flexible Hybrid Electronics North America TC Chapter

Meeting Summary and Minutes

Inaugural Meeting

Monday, September 18, 2023

13:00 – 14:30 Pacific

Virtual via Official Virtual TC Chapter Meeting (OVTCCM)

TC Chapter Announcements

Next TC Chapter Meeting

TBD

Table 1 Meeting Attendees

Co-Chairs: Randall Parker (ASI), Ahmed Busnaina (Northeastern University)
SEMI Staff: Laura Nguyen, Paul Trio

Company	*Last*	*First*	*Company*	*Last*	*First*
Air Force Research Lab	*Bazzan*	*Giorgio*	*NextFlex*	*Carter*	*Race*
American Semiconductor, Inc.	*Hacker*	*Douglas*	*NextFlex*	*Knapp*	*Marla K.*
American Semiconductor, Inc.	*Parker*	*Randall*	*NextFlex*	*Morris*	*Nick*
Auburn University	*Lall*	*Pradeep*	*NextFlex*	*Orrill*	*Michael*
Bayflex Solutions	*Tsuyuzaki*	*Eisuke*	*Northeastern University*	*Busnaina*	*Ahmed*
Binghamton University	*Gonya*	*Steve*	*Optomec*	*Christenson*	*Kurt*
Binghamton University	*Poliks*	*Mark*	*Siemens*	*Kavanaugh*	*Christy*
Boeing Research & Technology	*Williams*	*John*	*SunRay Scientific*	*Balder*	*Dan*
Brooks Automation	*Babbs*	*Daniel*	*SunRay Scientific*	*Leeuw*	*James*
ChemCubed	*Slep*	*Dan*	*Tapecon Inc.*	*Tudela*	*Rafael*
HP	*Wittkopf*	*Jarrid*	SEMI	Nguyen	Laura
Indium Corporation	*Mackie*	*Andy*	SEMI	Samadi	Gity
GE Aerospace, US	*Trivedi*	*Deepak*	SEMI	Trio	Paul

Table 2 Leadership Changes

WG/TF/SC/TC Name	*Previous Leader(s)*	*New Leader(s)*
FHE NA TC Chapter ***[Approved at the NARSC SEMICON West Meeting]***	–	Randall Parker (American Semiconductor Inc.) Ahmed Busnaina (Northeastern University)
FHE Assembly Task Force ***[New]***	–	Jarrid Wittkopf (HP) John Williams (Boeing)
FHE Design Task Force ***[New]***	–	Deepak Trivedi (GE Aerospace) Steve Gonya (Binghamton University)

Table 2 Leadership Changes

WG/TF/SC/TC Name	*Previous Leader(s)*	*New Leader(s)*
FHE Inks Characterization Task Force ***[New]***	–	Kurt Christenson (Optomec) Ahmed Busnaina (Northeastern University) Dan Slep (ChemCubed)
FHE Reliability and Testing Task Force ***[New]***	–	Pradeep Lall (AU) Giorgio Bazzan (AFRL)

Table 3 TC Chapter Structure Changes

Previous WG/TF/SC Name	*New WG/TF/SC Name or Status Change*
None	FHE Assembly Task Force ***[New]***
None	FHE Design Task Force ***[New]***
None	FHE Inks Characterization Task Force ***[New]***
None	FHE Reliability and Testing Task Force ***[New]***

Table 4 Ballot Results

None

Table 5 Activities Approved by the GCS between meetings of the TC Chapter

None

Table 6 Authorized Activities

Listing of all revised or new SNARF(s) and TFOF(s) approved by the Originating TC Chapter.

#	*Type*	*SC/TF/WG*	*Details*
–	TFOF	TF	FHE Assembly Task Force ***[New]***
–	TFOF	TF	FHE Design Task Force ***[New]***
–	TFOF	TF	FHE Inks Characterization Task Force ***[New]***
–	TFOF	TF	FHE Reliability and Testing Task Force ***[New]***

NOTE 1: SNARFs and TFOFs are available for review on the SEMI Web site at: http://downloads.semi.org/web/wstdsbal.nsf/TFOFSNARF

Table 7 Authorized Ballots

None

Table 8 SNARF(s) Granted a One-Year Extension

None

Table 9 SNARF(s) Abolished

None

Table 10 Standard(s) to receive Inactive Status

None

Table 11 New Action Items

None

Table 12 Previous Meeting Action Items

None

1 Welcome, Reminders, and Introductions

Randall Parker (ASI), called the meeting to order at 13:00 Pacific. The meeting reminders on antitrust issues, intellectual property issues and holding meetings with international attendance were reviewed. Attendees introduced themselves.

Attachment: SEMI Standards Required Elements (File name: Required Meeting Elements)

2 Review of Previous Meeting Minutes

N/A. This is the inaugural meeting of this TC Chapter meeting.

3 SEMI Virtual Meeting (SVM) Review

3.1 Laura Nguyen (SEMI Staff) instructed the members online how to vote on 'SVM' and practiced some test voting.

4 Liaison Reports

4.1 *Flexible Hybrid Electronics Taiwan TC Chapter*

Laura Nguyen (SEMI HQ) reported for the Taiwan TC Chapter. Of note:

Meeting Information

- Last meeting: May 19, 2023, at the SEMI Standards Taiwan 2023 Spring Meetings, Web Meeting, Taiwan.
- Next meeting: Oct. 4, 2023, at the SEMI Standards Taiwan 2023 Fall Meetings, Web Meeting, Taiwan.

TC Chapter Leadership *(Refer to attachment for Org Chart)*

- Co-chairs: Steve Ng/ AIQ, YE Yeh/ ASE

Ballot Results

- 6873, New Standard: *Guide for Salt Mist and Washability Test Flow for Control Module Connector of Electronic textiles* [Failed]

Authorized Ballots

- 6873A, New Standard: *Guide for Salt Mist and Washability Test Flow for Control Module Connector of Electronic textiles* [FHE System for Wearable Task Force]

Authorized Activities

- 7104, New Standard: *Test Method of Electromyography Sensing Technology of Flexible Hybrid Electronics and Electronic Textiles* [FHE System for Wearable Task Force]

Task Force Highlights

- FHE System for Wearable Task Force
    - Recently Published Standards

- SEMI FH1: Test Method of Line Impedance for Flexible Hybrid Electronics
- SEMI FH2: Test Method of Sheet Resistance for Woven Electronic Textiles
    - TF Leader and members are discussing about the promotion of these two standards to the FHE SIG committee for more exposure.

o Documents Under Development

- #6873: New Standard, Guide for Salt Mist and Washability Test Flow for Control Module Connector of Electronic textiles
    - Ballot failed and was returned to TF for rework. According to the reject comment; consult with Taiwan Textile Research Institute Expert for measurements
- #7104: New Standard: Test Method of Electromyography Sensing Technology of Flexible Hybrid Electronics and Electronic Textiles
    - Recently approved at the May 2023 meeting

Five Year Review: None

Staff Contact: Cher Wu, cherwu@semi.org

Attachment: TW FHE TC Chapter Liaison Report_Sept 2023_R2_LNN

4.2 *Flexible Hybrid Electronics Japan TC Chapter*

Laura Nguyen (SEMI HQ) reported for the Japan TC Chapter. Of note:

Meeting Information

- Last meeting: Friday, July 14, 2023, SEMI Japan Office + OVTCCM (Hybrid)
- Next meeting: Friday, October 13, 202, Yamagata University + OVTCCM (Hybrid)
    - To be jointly held with FPD Materials & Components Japan TC Chapter

TC Chapter Leadership *{Refer to attachment for Org Chart}*

- Co-chairs: Satoshi Maeda/ TOYOBO, Ryoichi Watanabe/ Japan Display Inc., Tadahiro Furukawa/ Yamagata University

Ballot Results: None

Authorized Ballots

- 6978, New Standard: *Test Method and Guide For The Tactile Characteristics Of Flexible Hybrid Electronics Materials And Products* Tactile [Texture Characteristics for FHE TF]

Task Force Highlights

- FHE Terminology Task Force
    - Co-Leaders: Satoshi Maeda (TOYOBO), Ryoichi Watanabe (Japan Display Inc.), Tadahiro Furukawa (Yamagata University)
    - The TF has been discussing what kind of standards are necessary to be developed while drafting Terminology standard.
    - Next TF meeting will be held on Thursday, October 12, 2023.
- Tactile Texture Characteristics for FHE Task Force
    - Co-Leaders: Mari Inoue (Kobe University), Satoshi Maeda (TOYOBO), Tadahiro Furukawa (Yamagata University)
    - The TF developed Doc.#6978, New Standard: TEST METHOD AND GUIDE FOR THE TACTILE CHARACTERISTICS OF FLEXIBLE HYBRID ELECTRONICS MATERIALS AND PRODUCTS, which includes both Test Method and Guide in it.

- Wearable electronics and e-textiles products are typical areas of application to which Flexible Hybrid Electronics (FHE) technology is applied. The tactile characteristics are measure key characteristics of product quality, as these products must be touched directly by humans or worn directly on parts of the body.
- The tactile characteristics evaluation techniques have been developed in the field of textile products, however, there are no any kind of standards and they are not well known in fields other than textile industry.
- Extending textile texture evaluation technology to FHE materials and products will have beneficial results for FHE product development.

- Doc.#6978 was submitted for Cycle 6 and the voting result will be adjudicated at the next TC meeting in October.
- Next TF meeting will be held on Thursday, October 12, 2023.

Staff Contact: Akiko Yoshida, ayoshida@semi.org

Attachment: JA FHE TC Chapter Liaison Report_Sept 2023_R1_distr

4.3 *SEMI Staff Report*

Laura Nguyen (SEMI) gave the SEMI Staff Report. Of note:

SEMI Global 2023 Calendar of Events

- SEMICON West (July 11-13; San Francisco. CA), SEMICON Taiwan (Sept 6-8; Taipei, Taiwan), SEMICON Europa (Nov 14-17; Munich, Germany), SEMICON Japan (Dec 13-15; Tokyo, Japan)

Upcoming NA Meetings

- NA Fall Meetings: November 6-9, 2023, at SEMI Headquarters in Milpitas, CA
- NA Spring Meetings: April 1-4, 2024 (Tentative), at SEMI Headquarters in Milpitas, CA
- SEMICON West Meetings: July 2024, at Moscone Center, San Francisco, California/USA

Critical Dates for SEMI Standards Ballots

2023	Ballot Submission Deadline	Voting Opens	Voting Closes
Cycle 6	July 26	August 9	September 8
Cycle 7	August 30	September 13	October 13
Cycle 8	October 4	October 18	November 17
Cycle 9	November 15	November 29	December 29

2023 Cycle dates can be found here: http://www.semi.org/en/Standards/Ballots

New Publications Staff

- Vivian Hoang – Sr. Specialist, Standards Publications
  - Joined SEMI May 17, 2023. Will focus on processing ballots to reduce backlog and improve publishing time.

Regulations and Procedure Manual updates

- *Regulations* (Feb 28, 2023)
  - Provide publication conditions for both Letter Ballot Review to pass procedural review and its Ratification Ballot is accepted.
    - If the Letter Ballot Review fails procedural review, the acceptance for the Ratification Ballot shall be nullified.

- https://www.semi.org/sites/semi.org/files/2023-02/Standards%20Regulations%20February%2028%2C%202023.pdf
- Procedure Manual (Feb 28, 2023)
  - Clarification on Line-Item Ballots are only permitted on revisions to already published identified portions of Standards or Safety Guidelines.
  - Revision of any Subordinate Standard causes the Publication Date Code of the Primary Standard to be considered as reapproved and it shall be given the (Reapproved mmyy) designation.
  - Contents of Background Statement Required for Revision of Subordinate/Primary Standard Letter Ballots.
  - https://www.semi.org/sites/semi.org/files/2023-02/Procedure%20Manual%20February%2028%2C%202023.pdf

Standards Publications Report

Cycle	*New*	*Revised*	*Reapproved*	*Withdrawn*
March 2023	2	1	0	0
April 2023	1	10	4	0
May 2023	0	4	2	0
June 2023	1	10	7	0

Total in portfolio – 1,079 (includes 327 Inactive Standards)

New Standards

Cycle	*Designation*	*Title*	*Committee*	*Region*
March 2023	SEMI FH1	Test Method of Line Impedance for Electronic Textiles	Flexible Hybrid Electronics	TW
March 2023	SEMI FH2	Test Method of Sheet Resistance for Woven Electronic Textiles	Flexible Hybrid Electronics	TW
April 2023	SEMI M92	Specification for 4H-SIC Homoepitaxial Wafer	Compound Semiconductor Materials	CH
June 2023	SEMI PV100	Test Method of Wind Uplift Resistance for Photovoltaic Modules Roof (BIPV)	Photovoltaic	CH

Attachment: Staff Report July 2023 v4_FHE

5 Ballot Review

None.

6 Proposed Activities

6.1 *FHE Assembly*

Jarrid Wittkopf (HP) presented for this activity. Of note:

- Leadership: Jarrid Wittkopf (HP), John Williams (Boeing)
- Current roster *{refer to attachment for details}*
- Proposed FHE Assembly TFOF
  - Charter : The TF's charter focus on detailing guidelines, benchmark testing, and initial joint/interface testing for the assembly of components/connectors onto FHE substrates with different attachment techniques, integration of FHE substrates with other FHE substrates and/or rigid boards, and assembly of FHE substrates to their final formfactor.

- Scope: The TF's scope is to develop standards on assembly techniques including but not limited to conductive adhesives, anisotropic conductive adhesive (ACA), anisotropic conductive films (ACF), solders, and printed conductors. In this scope we will define the testing for determining acceptable ranges of for assembly of passives, connectors, packaged actives, bare die, etc. for the different assembly techniques in the context of application needs (electrical, mechanical, thermal). This will factor in the full stack of materials needed in the assembly including: underfills, encapsulants, and rigid modifiers to support assembly.

- TF Interdependencies *{refer to attachment for images}*
  - Reliability on attachment level or pin level (at the joint). Determine reliability studies that focus on the failure or yield. We must meet the reliability test standards as well as the joint level reliability and test targets. FHE Ink characterization standards must be met to achieve assembly criteria and assembly placement criteria must meet the needs of the design standards TF.
- Testing Methodologies for Characterizing *{refer to attachment for images}*
  - What is being Standardized? and How will it be characterized?
  - The standards will provide guidance and identify initial testing for electrical and mechanical properties to determine the success criteria for the assembly.
  - Ensure our t=0 performance will be capable of meeting lifetime testing targets
    - Destructive testing: Cutting-polishing-microscopy, sheer testing, mechanical load testing
    - Non-destructive Testing: Electrical resistance of joint, x-ray tomography, acoustic testing
- Building the Grid *{refer to attachment for images}*
  - An excel file (also known as 'the gird') is being circulated within the Task Force to help organize "What do we want, and how do we do it?"
- Next Steps: Define first assembly technique to be investigated for standardization
- Next Meeting: Aim for first week of Oct (Thurs Oct 5 @ 1 PM PST), Set up a bi-weekly schedule

Attachment: SEMI Standards FHE Assembly TF_v4

6.2 *FHE Design*

Steve Gonya (BU) presented for this activity. Of note:

- Leadership: Deepak Trivedi (GE), Steve Gonya (BU)
- Current roster *{refer to attachment for details}*
- Proposed FHE Design TFOF
  - **Charter:** Align with FHE Technical Committee charter to explore, evaluate, discuss, and create consensus based FHE standards pertaining to design, covering design rules, manufacture flow, specifications, guidelines, and practices that, through voluntary compliance, will promote mutual understanding and improve communications between users and suppliers of FHE integrated systems, components, materials, and testing capabilities as well as enhance the design correctness and capability so as to improve the manufacturing efficiency and capability. Currently, there is no FHE design rule pertaining to durability, performance, environmental compatibility.
  - **Scope:** This TF will aim to explore and develop standards that pertain to design for substrates, interface, interconnects, and interdependencies at a system level. This TF will also take in consideration:
    - Testing required for successful design (i.e., material characterization data)
    - Analytical methods and modeling tools for design
    - Design tools for automating and streamline the design process.
- Technical Topics of Interest *{refer to attachment for images}*
  - Topics: Design for flex substrates, hard-to-soft interfaces, flex-to-flex interconnects, via interconnect, stretchable substrates, test equipment interface

- Next Steps:
    - SNARF activity discussion
    - First topic: design for flex substrates
- Next Meeting: October 3, 2023, 9 AM Pacific

Attachment: SEMI Standards FHE Design TF_v6

6.3 *FHE Inks Characterization*

Kurt Christenson (Optomec) presented for this activity. Of note:

- Leadership: Kurt Christenson (Optomec), Ahmed Busnaina (Northeastern University), Dan Slep (ChemCubed)
- Current roster *{refer to attachment for details}*
- Proposed FHE Inks Characterization TFOF
    - Charter: This TF will aim to explore and develop standards that will focus on evaluating incoming ink properties and printed short-loop test vehicles to determine the suitability of the ink for the production process.
    - Scope: This TF will utilize established tests to develop standards that pertain to reliability and testing of incoming inks. This TF will also take in consideration:
        - Design required for successful testing (E.g., test vehicles and integral test structures)
        - Analytical methods
        - Instruments
- Topics to Consider *{refer to attachment for images}*
    - Liquid Ink Testing, Printing, Post process, Printed Ink Testing
    - The Inks TF will focus on standards for incoming inks along with a small of immediately post-process tests.
- Next Steps:
    - Identify existing tests (i.e., ASTM…)
    - Identify and invite stakeholders
- Next Meeting: TBD

Attachment: SEMI Standards FHE Inks Characterization TF_v2

6.4 *FHE Reliability & Testing*

Pradeep Lall (Auburn University) presented for this activity. Of note:

- Leadership: Pradeep Lall (Auburn University), Giorgio Bazzan (CIV USAF AFMC AFRL/RXME)
- Current roster *{refer to attachment for details}*
- Proposed TFOF
    - Charter: Align with FHE Technical Committee charter to explore, evaluate, discuss, and create consensus-based FHE standards pertaining to the testing required to ensure the reliability of FHE integrated systems. Identify the pertinent data needed for reliability assurance and important variables that must be monitored during accelerated testing. Consistency in the acquired data will promote mutual understanding and improve communications between designers, users and suppliers of FHE integrated systems, including components, materials, and testing capabilities as well as enhance the design robustness and capability so as to improve the design and manufacturing efficiency and capability.
    - The TF will focus on evaluating incoming raw FHE assembly materials including but not limited to substrates, inks, interconnect materials, encapsulants, and electronic-components post shipment but

prior to use at the manufacturing site and in fabricated FHE test vehicles or products to determine the reliability of the combined design and production process.
    - Scope: This TF will aim to explore and develop standards that pertain to reliability and testing of incoming components, materials and fabricated FHE Integrated Systems. This TF will focus on:
        - Design required for successful testing (e.g., test vehicles and integral test structures)
        - Tools for assurance of consistency of the incoming material
        - Variables to be measured and reported as part of reliability test or screen
        - Analytical methods and modeling tools for predicting reliability
        - Hardware and software tools for automating and streamlining the testing process
- Reliability TF Summary of Areas and Gaps *{refer to attachment for images}*
    - Topics: Accelerated Tests and Test levels, Failure Modes and Mechanisms, Qualification of New and Replacement Materials, System - Level Qualification, Modeling Methods for Life Prediction
- Next Steps:
    - Work on the grid: FHE Integration with Components, Quality Assurance and Process Reliability, Review of External Standards for FHE, Identify the overlap and technology gaps
- Next Meeting
    - Oct 4th @11am CT

Attachment: PL_GB_SEMI Standards FHE Reliability & Testing TF_v2

7 Old Business

None

8 New Business

8.1 *Task Force Formation (TFOF approvals)*

Motion:	Approve the TFOF for the FHE Assembly Task Force.
By / 2nd:	By: Kurt Christenson / Optomec Second: Jarrid Wittkopf / HP Inc
Discussion:	None.
Vote:	13-0 in favor. Motion passed.

Attachment: TFOF_FHE Assembly_v2 9-18-23

Motion:	Approve the TFOF for the FHE Design Task Force.
By / 2nd:	By: Stephen Gonya / Binghamton University (SUNY) Second: Douglas Hackler / American Semiconductor, Inc.
Discussion:	None.
Vote:	12-0 in favor. Motion passed.

Attachment: TFOF_FHE Assembly_v2 9-18-23

Motion:	Approve the TFOF for the FHE Inks Characterization Task Force.
By / 2nd:	By: Pradeep Lall / Auburn University Second: John Williams / The Boeing Company
Discussion:	None.
Vote:	11-0 in favor. Motion passed.

Attachment: TFOF FHE Ink draft 7_7_23 kkc a_LNN changes accpeted 8_28_23

Motion:	Approve the TFOF for the FHE Reliability and Testing.
By / 2nd:	By: Daniel Slep / ChemCubed Second: Ahmed Busnaina / Northeastern University
Discussion:	None.
Vote:	13-0 in favor. Motion passed.

Attachment: TFOF_FHE Reliability & Testing_REV2

9 Action Item Review

9.1 New Action Items, if any, are noted in Table 11. Previous action items, if any, are noted in Table 12 in 'red' and for recent updates in 'blue'. There is no further business.

10 Next Meeting and Adjournment

10.1 Schedule details TBD. Please check www.semi.org/standards for updates.

Adjournment: 14:55

Respectfully submitted by:

Laura Nguyen

Sr. Coordinator, International Standards

SEMI Global Headquarters

Phone: +1.408.943.7019

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Minutes tentatively approved by:

Randall Parker (ASI), Co-chair	<Date approved>
Ahmed Busnaina (Northeastern University), Co-chair	<Date approved>

Minutes approved by: **XXXX**

Table 13 Index of Available Attachments[#1]

Title	*Title*
SEMI Standards Required Elements	SEMI Standards FHE Inks Characterization TF_v2
TW FHE TC Chapter Liaison Report_Sept 2023_R2_LNN	PL_GB_SEMI Standards FHE Reliability & Testing TF_v2
JA FHE TC Chapter Liaison Report_Sept 2023_R1_distr	TFOF_FHE Assembly_v2 9-18-23
Staff Report July 2023 v4_FHE	TFOF_FHE Design
SEMI Standards FHE Assembly TF_v4	TFOF FHE Ink draft 7_7_23 kkc a_LNN changes accpeted 8_28_23
SEMI Standards FHE Design TF_v6	TFOF_FHE Reliability & Testing_REV2

#1 Due to file size and delivery issues, attachments must be downloaded separately. A .zip file containing all attachments for these minutes is available at www.semi.org. For additional information or to obtain individual attachments, please contact Laura Nguyen at the contact information above.