FINAL

HIGH-LEVEL TECHNICAL ASSESSMENT OF METZILLA AND MONO PERC G1 5BB CELLS MADE WITH METZILLA

BV PROJECT NO. 422408

PREPARED FOR

Osazda Energy

15 AUGUST 2025

Table of Contents

LIST OF TABLES

LIST OF FIGURES

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1.0 Executive Summary

Osazda Energy ("Client") synthesizes an electrically conductive paste it refers to as MetZilla. Client retained Black & Veatch Management Consulting, LLC ("Consultant") to perform a high-level technical assessment of the MetZilla MZ22-10 formulation, referred to as MetZilla throughout this report ("Report") and the Mono PERC G1 5BB photovoltaic (PV) cells made by Client with MetZilla. This Report provides a summary of Consultant's high-level technical assessment.

1.1 Approach and Methodology

The Consultant team, comprised of professionals in chemical process and manufacturing experts, PV systems expert, project management, and supporting engineers, reviewed data provided by Client to perform a high-level technical assessment of MetZilla and the Mono PERC G1 5BB cells made by Client with MetZilla. Data requests for additional or updated documentation were submitted as necessary.

1.2 Assumptions

During the high-level technical assessment, Consultant used and relied upon certain information provided by the Client.

Consultant is of the opinion that the information provided is true, correct, and reasonable for the purposes of this Report. Consultant has not been asked to make an independent analysis to verify the information provided to us, or to render an independent judgment of the validity of the information provided by others. As such, Consultant cannot, and does not, guarantee the accuracy thereof to the extent that such information, data, or opinions were based on information provided by others. In preparing the Report and the opinions presented herein, Consultant has made certain assumptions with respect to conditions that may exist, or events that may occur in the future. Consultant is of the opinion that the use of this information and assumptions is reasonable for the purposes of this Report. However, some events may occur, or circumstances change in ways that cannot be foreseen or controlled by Consultant and that may render these assumptions incorrect. To the extent that the actual future conditions differ from those assumed herein, or provided to Consultant by others, the actual results will differ from those that have been forecast in this Report. This Report summarizes Consultant's high-level technical assessment of MetZilla and the Mono PERC G1 5BB cells made by Client with MetZilla. Throughout this Report, Consultant has stated assumptions and reported information provided by others, all of which were relied upon in the development and conclusions of this Report.

1.3 Nature and Purpose of the High-Level Technical Assessment

Client engaged Consultant to perform the following tasks:

- High-level review of MetZilla specification and chemical composition.
- High-level review of the current MetZilla manufacturing process
- High-level review of the data that substantiates the information contained in the Osazda Energy Mono PERC Cell G1 5BB data sheet (created 8/9/24; Revision status: V.01; Model name: MZ22-10).

- High-level review of the beginning of life (BOL) performance of Mono PERC Cell G1 5BB cells with MetZilla and “baseline” Mono PERC Cell G1 5BB at different temperatures and irradiance.
- High-level review the results of mechanical stress tests performed by Osazda on PV modules made with Mono PERC Cell G1 5BB with MetZilla and “baseline” Mono PERC Cell G1 5BB to induce cell cracks.

Consultant reviewed data shared by Client that included product specifications, test conditions, and results of tests performed by Client on MetZilla and Dupont^{TM} SolaMet® PV22A pastes, and Mono PERC G1 5BB cells made using MetZilla and Mono PERC G1 5BB cells made using Dupont^{TM} SolaMet® PV22A pastes. Consultant did not witness the manufacturing of MetZilla.

1.4 Conclusions

1.4.1 MetZilla Composition, Properties, and Manufacturing

- MetZilla is composed of two primary materials– commercially sourced Dupont^{TM} SolaMet® PV22A (”Baseline paste”) and carbon nanotubules (CNT). The low quantity of primary materials and the fact that they are provided by single suppliers implies that MetZilla properties can be impacted by variations in the chemical composition of the primary materials and supply chain issues with the suppliers. Consultant recommends that Client mitigate this risk by building strong relationships with the suppliers, implementing rigorous quality control procedures for incoming materials, and qualifying alternative suppliers.
- Consultant notes that important physical properties like MetZilla phase transition temperatures (melting and freezing points) are not available. Chemical properties like flammability are also not available. Consultant is of the opinion that the missing information is essential and strongly recommends that Client develop a complete list of physical and chemical MetZilla properties and update the MetZilla Safety Data Sheet to avoid hazardous operating and scale-up conditions and to design the work areas according to prevailing safety standards.
- Client currently manufactures MetZilla at laboratory scale. Consultant opines that the process equipment used to manufacture MetZilla should be available for larger-scale manufacturing. Equipment availability should not hinder MetZilla manufacturing scale-up.
- Consultant is of the opinion that the milling step in the MetZilla manufacturing process, in which the paste is passed 10 times through a three-mill roller, poses the highest risk for process scale-up. Client’s current MetZilla production capacity is 1 kg/day. The production capacity is limited by the quality of the output from milling. During scale-up, large batches of high-viscosity paste may become difficult to handle and may require alternative equipment settings. Consultant strongly recommends that Client develop a detailed process scale-up plan for the milling step. This plan should include equipment trials to prove the ability of handling large batches.
- Consultant is of the opinion that MetZilla processing steps like centrifugation, printing, visual inspection, and hand mixing are not currently of concern due to the Client’s low production capacity. However, Client should assess process automation and the transition from small batch to continuous production when considering MetZilla production scale-up.

- Consultant is of the opinion that operators working with MetZilla and its components should wear appropriate personal protective equipment (PPE) at all times; including gloves, lab coats or other dedicated uniforms, eye protection and breathing protection. Chemical handling of liquids and powders should be done in a fume hood or a well-ventilated area. As MetZilla causes skin irritation and could be potentially carcinogenic, eye washes and safety showers should be installed within easy access of locations where operators handle the product. Process wastewater should be properly treated and disposed of to mitigate the potential aquatic hazards, and the product should never be disposed of in drains.

- Client should develop standard operating procedures (SOPs) for each step of the current MetZilla manufacturing process. Each SOP should clearly state the safety risks of the process step, required PPE, and how to mitigate each safety risk. The SOPs should be clearly posted at each workstation and Client should provide mandatory safety training for all personnel working in the MetZilla manufacturing area.

- Consultant is of the opinion that Client has successfully created a laboratory scale process for synthesizing MetZilla. For Client to expand the process into a commercial-scale MetZilla manufacturing process, Consultant recommends that Client begin work in areas such as Process Design and Engineering, Process Planning, Equipment and Instrumentation, and Production and Quality Control.

1.4.2 Osazda Energy Mono PERC Cell G1 5BB Data Sheet Statements

- Client's datasheet states that the efficiency of the Osazda Energy Mono PERC Cell G1 5BB cells made with MZ2-10 ("MetZilla cells") is 0.024% higher than that of the cells made with PV22A ("Baseline cells"). Consultant reviewed information related to the performance of 1025 MetZilla cells and 208 Baseline cells made with 83 µm wide gridlines that indicates that the average efficiency of 1025 MetZilla cells was 21.64±0.2% , while the average efficiency of the 208 Baseline Cells was 21.62±0.2%. All the cells were made at the University of North Carolina-Charlotte using a commercial screen-printer and firing furnace. Consultant is of the opinion that the higher average efficiency is a positive result that indicates that the electrical performance of the MZ22-10 is comparable, and perhaps superior, to that of the PV22A on the tested cells. Client explained that they have metallography data that supports improved silver particle sintering when CNTs are added to the silver paste and data that supports improved contact resistance in MetZilla cells. Consultant encourages Client to further substantiate the increase in efficiency and understand its root cause. Consultant also encourages Client to prepare and measure the electrical performance of MetZilla and Baseline Cells with gridlines in the 20 to 30 µm range as 83 µm wide gridlines are not consistent with current commercial solar cell designs.

- Client's datasheet states that MetZilla cells have higher throughput of better efficiency cells. Consultant understands that the basis for this statement is the comparison of the histogram plots of cell maximum power point (P_{mpp}) for the 1025 MetZilla cells and 208 Baseline cells mentioned above. Consultant reviewed the histogram plots which indicate that the MetZilla and Baseline cells have similar average P_{mpp} values, however the fraction of cells with above average P_{mpp} values appears to be higher for the MetZilla cells. Consultant is of the opinion that, for the population of cells analyzed, this result is consistent with Client's claim.

- Client's datasheet states that MetZilla is more ductile and has superior fracture strength (7X) than the Baseline paste. Consultant reviewed stress-strain plots and fracture test results for MetZilla and Baseline samples. The results reviewed indicate that the MetZilla samples have a lower Young's modulus than the Baseline samples. Consultant is of the opinion that the MetZilla samples are likely more ductile than the Baseline samples and the reported fracture strength of the MetZilla samples is 7X higher than the Baseline sample average fracture strength.
- Client's datasheet states that MetZilla is capable of gap-bridging cell cracks >40 µm. Client replicated the three three-point beam bending method for evaluating the fracture behavior of crystalline silicon PV cell metallization established at National Renewable Energy Laboratory (NREL) reported in: N. Bosco, A. Chavez, V. Upadhyaya, and S. Han, "Fatigue-Like Behavior of Silver Metallization Gridlines and Proposed Damage Mechanics Model," presented at the 2020 47th IEEE Photovoltaic Specialists Conference (PVSC), 2020. Following the NREL method, Client created a crack in a 60 µm wide gridline printed and fired on a silicon wafer, continually increased the width of the crack and measured the width at which the crack hindered the gridline from conducting electrical current across the crack. Client refers to this width as Critical Crack Opening Displacement (COD). Client repeated this test on samples with gridlines made with PV22A, MZ22-10 and MZ22-04 and performed a Weibull analysis of the COD results. Consultant is of the opinion that the use of Weibull analysis to estimate the COD values is consistent with accepted engineering practice. The Weibull fit characteristic value of the COD for the MZ22-04 (43 µm) is higher than those of the MZ22-10 (28 µm) and PV22A (8 µm). The Weibull characteristic value indicates the COD value at which approximately 63.2% of the gridlines have failed to conduct electrical current across the crack. Consultant is of the opinion that Client's data indicates that approximately 63.2% of the gridlines made using MZ22-10 would fail to conduct electrical current across a 28 µm wide gap. Consultant is of the opinion that the data does not substantiate the datasheet statement that MetZilla paste (MZ22-10) is capable of gap-bridging cell cracks >40 µm.
- Client's datasheet states that MZ22-10 does not exhibit adverse effects on corrosion from damp heat, thermal shock (TS) and Highly Accelerated Stress Testing (HAST). Consultant understands that Client fabricated two, two-cell (2×1) mini-modules. One of the mini-modules consisted of two Baseline cells and the other mini-module consisted of two MetZilla cells manufactured using MZ22-04. The mini-modules were fabricated and tested at D2 Solar, a solar energy equipment supplier located in San Jose, CA. The mini-modules underwent TS and HAST testing The mini -module with MetZilla cells shows decreases in maximum power output after TS and HAST testing that are comparable to those of the mini-module made with Baseline cells. Consultant is of the opinion that the results appear to indicate that the effects leading to the decreases in maximum power output on the mini-module with MetZilla cells and the mini-module made with Baseline cells after TS and HAST testing are comparable.

  Consultant reviewed the Client- commissioned test report: "Mechanical, Thermal, and Humidity Stress Testing and Comparison of D2 Solar Custom Backsheet and Control Modules for Client"(CFV Solar Test Laboratory, report number 24095-PR-E-001, dated March 11, 2025) According to the CFV report, CFV Labs conducted mechanical, thermal, and humidity stress testing referencing standard IEC 61215-2:2021(Crystalline Silicon terrestrial photovoltaic(PV) modules - Design qualification and type approval) on a total of 10 modules produced by D2 Solar. Five modules contained Mono PERC Cell G1 5BB cells made with MetZilla ("MetZilla modules") and the other five modules incorporated Mono PERC Cell G1 5BB cells made with PV22A ("Baseline modules"). Testing was divided into three test legs devised by CFV Labs - mechanical stress, thermal stress, and humidity stress.

The CFV report states that the changes in maximum power output after exposure to:

- 600 thermal cycles of two full-size modules manufactured by D2 Solar using MetZilla cells (OSA modules) and two full-size modules manufactured by D2 Solar using Baseline cells (Control modules) were -2.59% for the OSA modules and -1.88% for the Control modules.
- 2000 hours of damp heat of another OSA module and another Control module were -1.56% for the OSA module and -2.12% for the Control module.

Consultant is of the opinion that these results do not appear to indicate substantial differences in changes in maximum power output in between the MetZilla and Baseline modules after exposure to 200 thermal cycles or 2000 hours of damp heat.

The results of the testing of the two mini-modules and the three OSA and three Control modules are encouraging. Consultant recommends that Client test a larger number of modules to further substantiate the statement of no adverse effects on corrosion from damp heat, thermal shock and HAST.

- Client's datasheet states that viscosity and fineness of grind of MZ22-10 match those of baseline commercial paste. Client provided the results of viscosity measurements as a function of shear, on MZ22-10 and PV-22A performed using a Brookfield brand model DV viscosimeter (equipped with small sample adapter #14) at 20 °C. The data shows that the PV-22A and MZ22-10 pastes behave similarly. Client also performed side-by-side fineness of grind measurements on PV22A and MZ22-10 using a Hegman gauge to determine the effectiveness of Client's mixing process and the approximate size of the CNT agglomerates in the paste. The results show that the MZ22-10 values were well within the fineness of grind specifications for PV22A.
- Client's datasheet states that MZ22-10 and PV22A pastes have comparable screen-printing performance. Consultant reviewed a summary of a screen printing of MZ22-10 and PV22A pastes performed by Client using a semi-manual screen printer with a 640 mesh count screen and a 55 μm wide opening. The print results from both pastes show similar print line definition. However, the MZ22-10 print line showed sharper apex than the PV22A print line. Consultant also reviewed a summary of print line data where a third-party vendor printed MZ22-10 and two other commercial pastes identified as EE10 and J6574. The print line widths and heights of all three pastes were comparable.

1.4.3 Mechanical Stress Tests Performed by Osazda on PV Modules made with Mono PERC Cell G1 5BB with MetZilla and "Baseline" Mono PERC Cell G1 5BB to Induce Cell Cracks

- According to the CFV report referenced above, CFV performed EL imaging of each OSA module and Control Module before, during, and at the end of each stress leg. Consultant reviewed the EL images and observed that there were small changes in the EL images of the OSA and Control modules before, during, and after the humidity stress and thermal stress legs. However, there were significant changes in the EL images of the two Control modules in the mechanical stress leg, while the changes in the EL images of the two OSA modules in the mechanical stress leg were noticeably smaller. Consultant recommends that Client test more OSA and Control modules to confirm this different behavior and establish its root cause. If similar differences in the EL images between the OSA and Control modules are seen in a larger module population, this could be an important finding.

- Consultant reviewed a summary of the pressure cycling results performed by Sandia National Labs on two Osazda-provided modules. The summary showed pre- and post- pressure cycling EL images of each module for the following pressure cycling sequences:
    - Module OSA-24-001 PV22 (Baseline module)
        - 500 cycles +/- 500 Pa
        - 1500 cycles +/- 500 Pa
        - 1500 cycles +/- 500 Pa; 500 cycles +/- 1000Pa
    - Module OSA-24-002 MV22 (MetZilla Module)
        - 500 cycles + 80Pa /- 500 Pa
        - 1500 cycles + 80Pa/+ /- 500 Pa
        - 1500 cycles + 80Pa/+ /- 500 Pa; 500 cycles +/- 1000 Pa Cycles

All the Sandia National Labs pressure cycling EL images for the Baseline module showed many defects. However, the defect pattern did not appear to change significantly before and after the pressure cycling sequences.

All the Sandia National Labs pressure cycling EL images for the MetZilla module showed fewer defects than the OSA – 24-001 PV22 and the defect pattern did not exhibit significant changes before and after the pressure cycling sequences.

2.0 High-Level Review of MetZilla Specification and Chemical Composition

2.1 Key MetZilla Materials and Components

MetZilla is derived from Dupont^{TM} SolaMet® PV22A, a commercial photovoltaic metallization front-side paste used throughout the PV industry in fine-line printing for PERC cells. The primary composition of MetZilla is shown in Table 2-1:

Table 2-1 Composition of MetZilla Paste

Source	Chemical Constituent	Percentage by Weight
Dupont^{TM} SolaMet® PV22A	Silver spherical particles with a bimodal size distribution of 350 nm – 1.27µm	90%
	(2-butoxy ethoxy) ethyl acetate (Organic solvent)	10%
	Fatty acid salts of polyamines (Lubricant)	
	Organic binder	
	Lead oxide or glass frit	
Confidential	Carbon nanotubes	

Client explained that:

- The CNT vendor has assisted Client in developing the optimal CNT type, shape, functionalization, and suspension vehicle for MetZilla.
- MetZilla uses long, single-walled CNTs (SWCNTs) with 1-1.2 nm diameter and 1-50 µm rope lengths. CNT concentration in MetZilla MZ22-10 is Client's intellectual property and is in the range of 0.01 – 10 wt%.
- Silver paste manufacturers, such as Dupont, frequently modify their products and Client evaluates the compatibility of CNTs with every silver paste batch it purchases.

2.2 Physical and Chemical Properties

The key MetZilla physical properties are summarized in Table 2-2:

Table 2-2 Physical Properties of MetZilla

Property	Value
Melting and Freezing Points	Information not available
Density (Room Temperature)	5.60 g/cm^3
Viscosity	170.0 -350.0 Pa-s
Flash Point	100-120°C
Shelf life	MetZilla shelf life is estimated to be around six months[1]

[1] SolaMet® PV22A, a key MetZilla component, has a shelf life of six months from the date of shipment when stored in factory sealed containers at temperatures between 5 and 30 °C.

Consultant notes that important physical properties like phase transition temperatures (melting and freezing points) are not available. Chemical properties like flammability are also not available. Consultant is of the opinion that the missing information is essential and strongly recommends that Client develop a complete list of physical and chemical MetZilla properties and update its Safety Data Sheet to avoid hazardous operating and scale-up conditions, and to design the work areas according to prevailing safety standards.

2.3 Hazardous Materials in MetZilla

According to the Client-provided MetZilla MZ22 -10 safety data sheet, issue date 04/02/2025 (Appendix A), MetZilla has the following hazards classification:

Table 2-3 MetZilla Hazards Classification

Hazard	Category	Explanation	Regulation
Skin sensitization	1	There is evidence in humans that the substance can lead to sensitization by skin contact in a substantial number of persons	Regulation 1272/2008 (CLP)
Carcinogenicity	2	Suspected human Carcinogen	Regulation 1272/2008 (CLP)
Reproductive toxicity	1A	Known human reproductive toxicant.	Regulation 1272/2008 (CLP)
Short-term (acute) aquatic hazard	1	Very toxic to aquatic life	Globally Harmonized System of Classification and Labelling of Chemicals
Short-term (chronic) aquatic hazard	1	Very toxic to aquatic life with long lasting effects	Globally Harmonized System of Classification and Labelling of Chemicals
Acute toxicity, Oral	4, H302	Harmful if swallowed	Globally Harmonized System of Classification and Labelling of Chemicals
Eye irritation	2A, H19	Effects on the cornea, iris or conjunctiva that fully reverse within 21 days.	Globally Harmonized System of Classification and Labelling of Chemicals

MetZilla is a Category IA reproductive toxicant, implying that it has known reproductive toxicity effects, largely based on human evidence. It also has the following classifications:

- Category I in skin sensitization
- Category I as both a short-term and long-term aquatic hazard
- Category 2 carcinogenicity
- Category IIA eye irritation.

Consultant is of the opinion that:

- Operators working with MetZilla and its components should wear appropriate personal protective equipment (PPE) at all times; including gloves, lab coats or other dedicated uniforms, eye protection and breathing protection. Chemical handling of liquids and powders should be done in a fume hood or a well-ventilated area. As MetZilla causes skin irritation and could be potentially carcinogenic, eye washes and safety showers should be installed within easy access of locations where operators handle the product. Process wastewater should be properly treated and disposed of to mitigate the potential aquatic hazards, and MetZilla should never be disposed of in drains.
- Client should:
  - Develop standard operating procedures (SOPs) for each step of the current MetZilla manufacturing process. Each SOP should clearly state the safety risks of the process step, required PPE, and how to mitigate each safety risk.
  - Clearly post the relevant SOPs at each workstation.
  - Provide mandatory safety training for all personnel working in the MetZilla manufacturing area.

2.4 Key Material Supply Chain Risks in the Manufacturing of MetZilla

MetZilla is composed of two primary materials: commercially sourced Dupont^{TM} SolaMet® PV22A, and CNTs prepared specifically for Client by its supplier. Consultant is of the opinion that having single suppliers for each of the primary MetZilla materials exposes Client to significant supply chain risk. MetZilla quality can be impacted by variations in the composition of the primary materials and MetZilla manufacturing can be severely disrupted if Dupont or its CNT supplier fail to meet their product delivery commitments. Consultant strongly recommends that Client take steps to mitigate the supply chain risks by building strong relationships with the current suppliers, implementing rigorous incoming material quality control procedures, and qualifying alternative suppliers.

2.5 MetZilla Synthesis Process

The MetZilla synthesis process is summarized as a block flow diagram in Figure 2-1 and described in the following paragraphs:

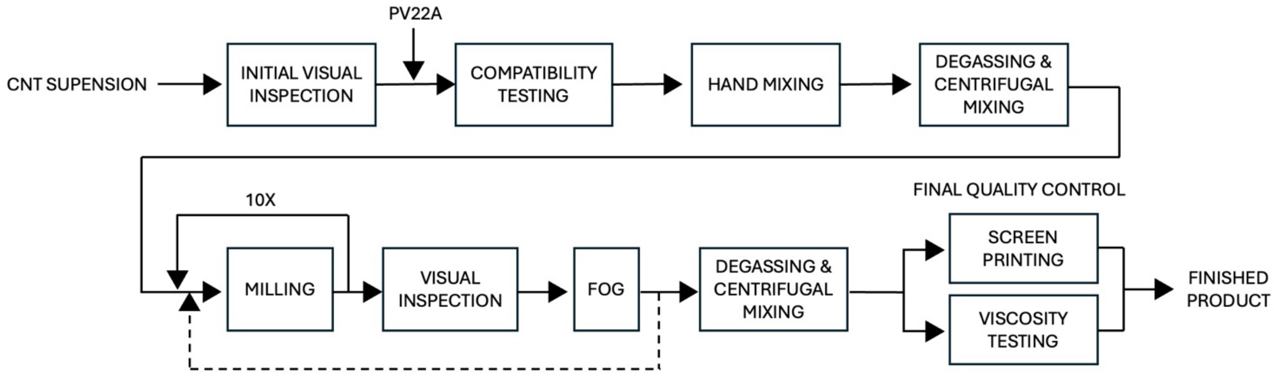

Figure 2-1 **Block Flow Diagram Showing MetZilla Synthesis**

Step 1- CNT suspension inspection- Client acquires a suspension of CNTs in (2-butoxy ethoxy) ethyl acetate. Use of the CNT solution facilitates the mixing of the PV22A and CNTs during the MetZilla synthesis. Prior to using the CNT suspension, Client visually inspects the CNT suspension to establish that there is no visible separation between the CNTs and the solvent. If separation is observed, Client will reject the CNT suspension.

Step 2- PV22A – CNT compatibility test - Client explained that it tests the compatibility of each batch of PV22A with the CNTs before using the PV22A in the MetZilla synthesis process. To establish compatibility, Client subjects a 25g sample of PV22A and CNT suspension to steps 2-6 below and visually inspects the resulting mixture for separation of PV22A and the solvent during a period of up to eight hours. If separation happens, Client will reject the PV22A batch.

Step 3- Hand-mixing of the CNT solution and PV22A- Client hand mixes the CNT suspension and PV22A in a ratio of 0-01 to 10 % by weight of CNT to silver (Ag) until a homogeneous mixture is obtained. The hand mixing is performed with a spatula. Client visually inspects the mixture to establish that there is no separation between the CNTs and the PV22A.

Step 4- Centrifugal degassing and mixing - Client places the homogeneous mixture in a RobotDigg brand solder paste planetary centrifugal mixer for degassing and high velocity mixing. Upon completion the mixture should be a smooth paste. Client visually inspects the mixture for non-homogeneities or bubbles.

Step 5 – Milling - Client unloads the CNT-PV22A mixture and loads it on a Torrey Hills Technologies brand model T65B Three Roll Mill, designed for nano-dispersion in high-viscosity pastes. The mixture is passed at least 10 times through the T65B Three Roll Mill with roller speed and gap between the rollers set to maximize CNT dispersion and minimize CNT agglomeration. At that point Client randomly chooses up to three samples of mixture at the exit point of the mill and visually inspects the paste under a microscope to establish that there are no CNT agglomerates with a linear dimension greater than 10 μm. Client also performs fineness of grind (FOG) measurements using a Hegman gauge on the mixture and the PV22A used in the mixture. The FOG of the mixture should be the same as that of the commercial baseline paste and should not exceed 12 μm. Client performs additional passes of the mixture through the Three Roll Mill until no further reductions are observed in CNT agglomerate size and FOG value.

Step 6- Centrifugal degassing and mixing – Client places the mixture in the same RobotDigg brand solder paste planetary centrifugal mixer for degassing and additional mixing. Upon completion, Client performs a visual inspection for agglomerates or bubbles.

Step 7- Final Quality Control –

- **Viscosity measurement** - Client measures the viscosity of the mixture using a Brookfield brand viscosimeter. If the mixture viscosity does not meet Client's specification, Client takes actions to modify the viscosity of the mixture which may involve repeating some of the process steps. Client explained that viscosity is typically measured up to three times during the preparation of a batch of MZ22-10.
- **Screen printing –** Client uses the mixture to screen prints lines that are 20 to 60 μm wide. Client visually inspects the printed lines for non-uniformities, breaks, or other flaws. If such mixture-related defects are found, Client will identify and address the root causes,

Consultant understands that the MetZilla synthesis is done at room temperature and pressure. Consultant is of the opinion that none of the steps in the MetZilla synthesis pose safety concerns beyond those described in Section 2.2.

2.6 Scaling-up the MetZilla Synthesis Process

Client's current MetZilla synthesis capacity is 1 kg/day. The synthesis is performed in batches of 1 kg and involves significant manual intervention.

Consultant reviewed each process step for scaling up the MetZilla batch synthesis process. Table 2-4 provides Consultant's opinion on the batch process scale-up.

Table 2-4 Scale-Up of Different Steps in the MetZilla Batch Synthesis Process and the Associated Risks

Current Synthesis Process Step	Description	Consultant's Opinion on Scale–up
1	CNT suspension inspection	This step should not pose difficulties for scale-up. It can be carried out in a quality assurance laboratory setting separate from the manufacturing line.
2	PV22A – CNT compatibility test	This step currently involves the use of the same equipment used in the MZ22-10 synthesis. This could impact manufacturing throughput. Consultant is of the opinion that this step could be performed on laboratory scale equipment separate from the scaled-up manufacturing line.
3	Hand-mixing of the CNT solution and PV22A	Client currently mixes the PV22A and CNTs manually. Consultant is of the opinion that the batch mixing process can likely be scaled up using commercially available mixing equipment. Consultant recommends that Client: • Clearly define the mixing process technical specifications, quality requirements, uptime, and throughput objectives. • Perform a detailed assessment of commercial mixing equipment that can meet Client's requirements. • Once decided which equipment to purchase, Client should work with the equipment provider to develop Standard operating procedures (SOP) for the proper use and maintenance of the equipment to ensure that it meets Client's product quality, uptime, and throughput requirements throughout the useful life of the equipment.
4	Centrifugal Degassing and mixing	Client currently performs centrifugal degassing and mixing in a RobotDigg brand solder paste planetary centrifugal mixer with a maximum capacity of 1 kg/day. Scale-up will require the use of multiple 1 kg/day planetary centrifugal mixers or a larger mixer than can meet Client's performance specifications and required production capacity. Consultant is of the opinion that planetary mixers are commercially available from a range of suppliers and finding appropriate mixers is unlikely to be a barrier to scale-up.

Current Synthesis Process Step	Description	Consultant’s Opinion on Scale–up
5	Milling	The maximum throughput of the Torrey Hills Technologies brand T65B Three Roll Mill currently used in the milling process is 8 kg/hr of MetZilla based on the equipment’s specification. Processing larger quantities of PV22A and CNT mixtures will require more units of similar milling equipment or larger milling equipment. Consultant is of the opinion that achieving uniformity of CNT dispersion and minimizing CNT agglomeration in larger batches will likely require further process development and possibly process automation. Consultant is of the opinion the milling process may present a significant risk to production scale-up.
6	Centrifugal Degassing and mixing	See step 4
7	Final Quality Control	This step should not pose difficulties for scale-up. It can be carried out in a quality assurance laboratory setting separate from the manufacturing line.

3.0 High-Level Review of the Current MetZilla Manufacturing Process

3.1 Step by Step Assessment of the MetZilla Manufacturing Process

Client's MetZilla manufacturing process is described in section 2.5 (MetZilla Synthesis Process). The manufacturing process is designed for small-scale batch production and is performed in a laboratory environment with a manufacturing capacity of 1 kg/day. Consultant understands that Client manufactures MetZilla when an order is received and that manufacturing does not occur regularly. To date Client has manufactured 10 – 20 kg of MetZilla for experimental purposes and 1 kg was provided to a commercial client. Consultant did not witness the manufacturing process.

Based on the information provided by Client, Consultant is of the opinion that Client has successfully created a laboratory scale process for synthesizing MetZilla. For Client to expand the process into a commercial-scale MetZilla manufacturing process, Consultant recommends that Client begin work in areas such as:

- Process Design and Engineering
    - Develop detailed process specifications, material requirements and performance standards.
    - Design the process to reduce costs, enhance quality and simplify operations.
    - Verify the design and engineering concepts through experiments and trial runs.
- Process Planning
    - Choose the most suitable manufacturing processes based on material requirements, production volume, cost considerations, and others.
    - Define the optimum sequence of operations.
    - Identify required equipment, instrumentation, personnel, and materials.
    - Create detailed documentation for each process step.
- Equipment and Instrumentation
    - Select the equipment and instrumentation required for the manufacturing process.
    - Set up and calibrate equipment and instrumentation to ensure accuracy and consistency.
- Production and Quality Control:
    - Validate the manufacturing process through trial runs and to identify potential problems.
    - Establish quality control procedures at each stage of the manufacturing process to minimize scrap or rework.
    - Create rigorous inspection and testing procedures to ensure consistent MetZilla quality and identify defects.
    - Collect and analyze process and quality control data to pinpoint problems and implement corrective actions.

3.2 Quality Assurance Systems in Place

Client did not provide any databases, documentation control procedures, manuals, or personnel training procedures for review. Consultant is of the opinion that Client should develop a quality assurance program that should include, at a minimum, the management of the quality of the:

- Materials and components used in MetZilla manufacturing.
- MetZilla production process.
- Inspection processes performed during the manufacturing process.

Client stated that they maintain all data backups on a company-owned PC that is not connected to the internet. Copies of datasets and documentation are backed up on an external hard drive and on cloud storage for accessibility. Trade secrets are documented in a private handwritten lab notebook that is stored in an undisclosed location.

3.3 Quality Control Procedures during Production

See Section 2.5.

3.4 Manufacturing Capacity

Client's current facility can produce approximately 1 kg of paste per day.

3.5 Safety Risks in Manufacturing MetZilla

See Section 2.3 for an analysis of the Client-provided MetZilla Material Safety Data Sheet and Consultant's recommended safety measures when working with MetZilla,

Client explained that safety measures in place in the MetZilla manufacturing process include proper chemical handling to avoid unnecessary exposure to chemicals. Hand-mixing of the CNT solution and PV22A (step 3 of the MetZilla manufacturing process, section 2.5) is performed in a well-ventilated area and under a laminar flow hood. Osazda personnel are required to wear gloves, safety glasses, and a lab coat when mixing. The three-roll mill poses the most significant safety risk due to its exposed rollers during the mixing process. Loose clothing is not permitted during mixing, and distractions such as electronics or other media are not permitted during this process. There is a safety shutoff for the mill, but utmost care is to be taken when operating.

3.6 Safety Risks in using MetZilla in the Manufacturing of Mono PERC G1 5BB Cells

Client states that there is no additional safety risks associated with MetZilla compared to the Dupont PV22A silver paste product.

4.0 High-Level Review of the Data that Substantiates the Information Contained in the Osazda Energy Mono PERC Cell G1 5BB Data Sheet (created 8/9/24; Revision status: V.01; Model name: MZ22-10).

4.1 Data Sheet Statement - MetZilla Cells have 0.024% Higher Efficiency

Client provided information related to the performance of 1025 units of Osazda Energy Mono PERC Cell G1 5BB made with MZ22-10 (“MetZilla cells”) and 208 units of cells of the same design made with Dupont ™ PV22A (“Baseline cells”). All the cells we made at the University of North Carolina-Charlotte using a commercial screen-printer and firing furnace. Cell performance was measured using a Sinton Instruments brand model FCT-450 flash cell tester at standard test conditions (STC) - 1000 W/m^2 , AM 1.5, 25°C.

Some of the physical characteristics of the MetZilla and Baseline cells tested are shown in Table 4-1.

Table 4-1 Physical Properties of the Mono PERC Cell G1 5BB Cells Manufactured by UNCC

Properties	Description
Dimension	158.75 mm x 158.75 mm ± 0.25 mm
Thickness (silicon)	180 µm ± 20 µm
Front Side (-)	Blue silicon nitride anti-reflection coating 70-80 nm thick; emitter sheet resistance 95-100 ohm-cm; 5 silver busbars (0.8 ± 0.1 mm); gridline width 83 µm
Back Side (+)	Full-surface aluminum BSF; 5 × 4 soldering pads; 1.2 mm ± 0.1 mm wide silver/aluminum busbars

Table 4-2 shows the electrical characteristics of the MetZilla and Baseline cells.

Table 4-2 Electrical Characteristics Comparison

Parameter	Symbol and Unit	Baseline	MetZilla
Efficiency	η (%)	21.62 (±0.2)	21.64 (±0.2)
Fill Factor	FF (%)	80.88 (±0.4)	80.79 (±0.4)
Rated Power	Pmpp (W)	5.316 (±0.04)	5.322 (±0.05)
Max Power Voltage	Vmp (V)	0.570 (±0.002)	0.568 (±0.003)
Max Power Current	Imp (A)	9.330 (±0.06)	9.368 (±0.06)
Open Circuit Voltage	Voc (V)	0.666 (±0.001)	0.666 (±0.003)
Short Circuit Current	Isc (A)	9.860 (±0.05)	9.889 (±0.05)

Consultant reviewed the Client- provided raw data excel file ("PERC IV Data.xlsx") to compare the electrical parameters shown in Table 4-2 . Consultant is of the opinion that the higher average efficiency is a positive result that indicates that the electrical performance of the MZ22-10 is comparable, and perhaps superior, to that of the PV22A on the tested cells. Client explained that they have metallography data that supports improved silver particle sintering when CNTs are added to the silver paste and data that supports improved contact resistance in MetZilla cells. Consultant encourages Client to further substantiate the increase in efficiency and understand its root cause. Consultant also encourages Client to prepare and measure the electrical performance of MetZilla and Baseline cells with gridlines in the 20 -30 μm range as 83 μm wide gridlines are not consistent with current commercial solar cell designs.

4.2 Data Sheet Statement - MetZilla Cells have Higher Throughput of Better Efficiency Cells

Consultant understands that the basis for this statement is the comparison of the histogram plots of cell maximum power point (P_{mpp}) for the MetZilla and Baseline cells for the cell populations described in Section 4.1. The histogram plots appear in Figure 4-1 below. Both histogram plots have similar average P_{mpp} values, however the fraction of cells with above average P_{mpp} values appears to be higher for the MetZilla cells. Consultant is of the opinion that this is a positive result. Consultant recommends that Client perform a similar comparative study for cells with gridline widths in the 20-30 μm range which are currently used in solar cell manufacturing,

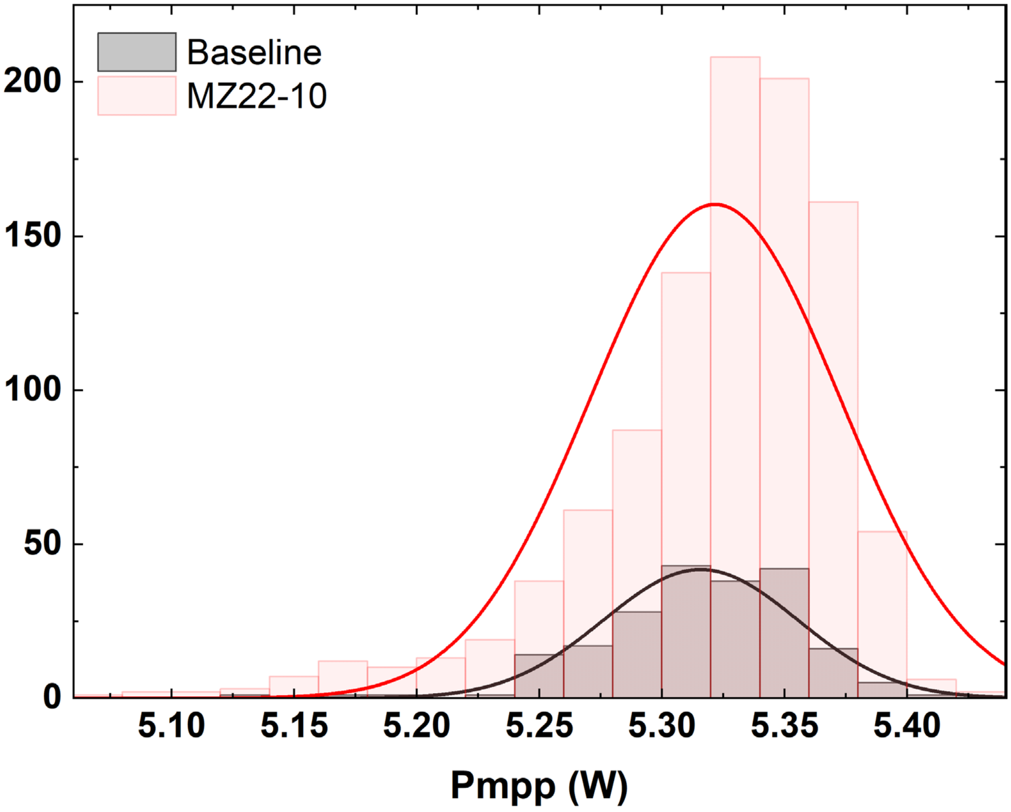

Figure 4-1 Maximum Power Point Histogram Plots for MetZilla and Baseline Cells

4.3 Data Sheet Statement - MetZilla Paste is more Ductile and has Superior Fracture Strength (7X)

Client conducted in-house stress-strain testing on samples of MetZilla and Baseline paste. Tension testing was performed on free-standing Baseline and MetZilla test lines using TA Instruments Q800 Dynamic Mechanical Analyzer (DMA). The shape of the samples used in the tests followed the American Society for Testing and Materials (ASTM) D638- 14 "Standard Test Method for Tensile Properties of Plastics" to concentrate stress in the center of the specimen and prevent sample failure at the clamping points. Client prepared five test samples of PV22A, five test samples of MZ22-10, and five test samples of MZ22-04 The samples were prepared by screen-printing the pastes on a polished silicon wafer and then firing the screen-printed samples in a nitrogen-rich atmosphere to prevent the formation of a metallurgical bond between the paste and the silicon wafer. This resulted in stand-alone test samples of the fired pastes that were not attached to the silicon wafers. The tensile clamp from the DMA was fixed at the top clip, and the bottom clip was free to apply stress to the sample. Stress was applied to achieve a constant strain rate of 0.05 %/min and the samples were stressed to failure. The MetZilla samples had two different compositions:

1. The MZ22-04 samples contained short multi-walled carbon nanotubes (MWCNT).
2. The MZ22-10 samples contained long single-walled carbon nanotubes (SWCNT).

Client calculated the Young's modulus and Modulus of Toughness of MZ22-04 and MZ22-10 samples and compared those to PV22A samples. Young's modulus is an indicator of a material's tensile or compressive stiffness when the stress is applied lengthwise. It is a generally accepted measure of a material's elasticity. A higher value of Young's modulus indicates a higher stiffness of the material. Modulus of toughness, on the other hand, is a standard measure of a material's ability to absorb energy and deform without fracturing. It is a well-accepted measure of strength and ductility of a material.[1] The Client-provided average stress-strain curves of the samples are shown below in Figure 4-2:

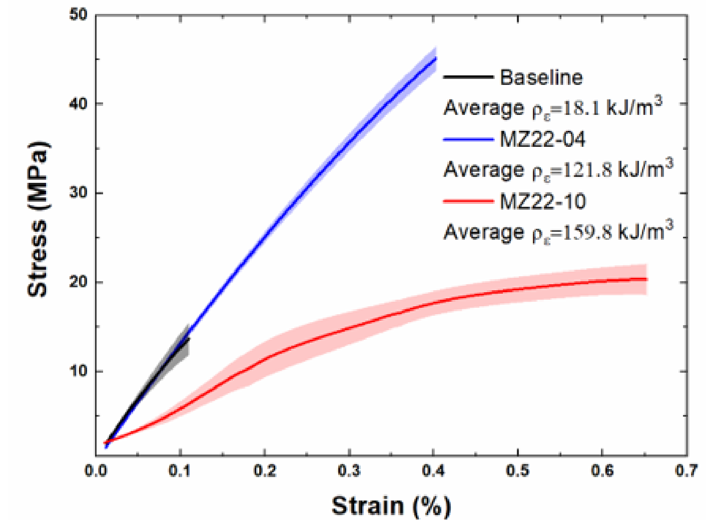

Figure 4-2 **Stress vs Strain Curves (Showing Average Modulus of Toughness Values)**

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[1] Fundamentals of Structural Engineering by Jerome J. Connor and Susan Faraji, Springer (2013)

Based on Figure 4-2, Consultant notes the following:

- The baseline samples failed at 0.1% strain. MZ22-04 failed at 0.4% strain and MZ22-10 failed at 0.65% strain. Both MetZilla formulations had higher fracture strength than the baseline samples.
- MetZilla MZ22-10 samples (red curve in Figure 4-2) exhibited lower Young's modulus than the MZ22-04.

The results from the stress-strain tests in Figure 4-2 are summarized in Table 4-3:

Table 4-3 Fracture Test Results

Properties	Baseline	MZ22-04	MZ22-10
Youngs Modulus [GPa]	13.74 (±1.21)	12.42 (±1.04)	5.57 (±2.00)
Change from baseline	0	-9.58%	-59.46%
Modulus of Toughness [kJ/m3]	18.07 (±5.67)	121.81 (±33.92)	159.40 (±87.98)
Change from baseline	0	574%	782%

Consultant is of the opinion that the results in Figure 4-2 and Table 4-3 indicate that the MZ22-10 samples on average:

- have a lower Young's modulus value that the average baseline samples. The MZ22-10 samples are likely more ductile than the baseline samples.
- have 7X higher fracture strength than the baseline average.

Consultant recommends that Client conduct more testing on how the chemical composition of MetZilla impacts the samples fracture strength, Young's Modulus, and Modulus of Toughness, and have a third-party test lab to validate the results obtained from in-house testing.

4.4 Data Sheet Statement - MetZilla Paste is Capable of Gap-Bridging Cell Cracks (>40 µm)

Client replicated the three three-point beam bending method for evaluating the fracture behavior of crystalline silicon PV cell metallization established at National Renewable Energy Laboratory (NREL) reported in: N. Bosco, A. Chavez, V. Upadhyaya, and S. Han, "Fatigue-Like Behavior of Silver Metallization Gridlines and Proposed Damage Mechanics Model," presented at the 2020 47th IEEE Photovoltaic Specialists Conference (PVSC), 2020. Following the NREL method, Client created a crack in a 60 µm wide gridline printed and fired on a silicon wafer, continually increased the width of the crack and measured the width at which the crack hindered the gridline from conducting electrical current across the crack. Client refers to this width as Critical Crack Opening Displacement (COD). Client repeated this test on samples with gridlines made with PV22A, MZ22-10 and MZ22-04. Client tested a minimum of 20 samples of each gridline type and performed a Weibull analysis of the COD results. Consultant understands that Weibull analysis is a statistical method used to analyze data that follows a Weibull distribution, which is a continuous probability distribution often used to model parameters such as the life expectancy of products, the time until a machine fails, and other values. Consultant is of the opinion that the use of Weibull analysis to estimate the COD values is consistent with accepted engineering practice. The Weibull plot of the results appear below:

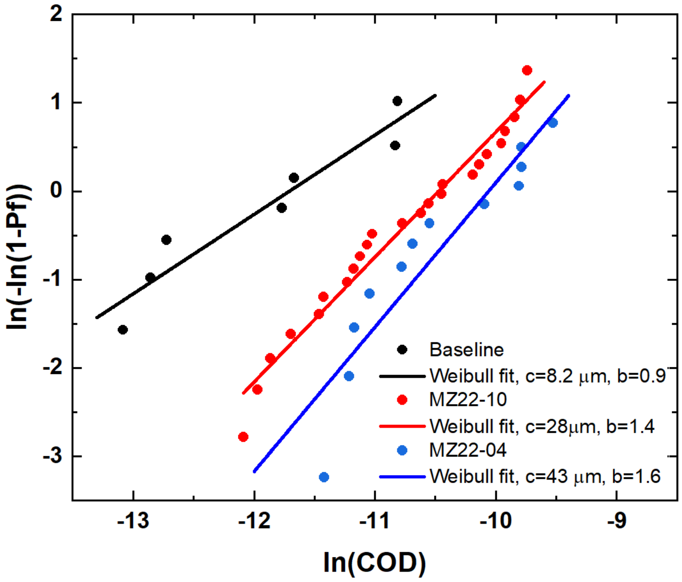


Figure 4-3 Weibull Plot of Critical Crack Opening Displacement (COD) Results

The Weibull fit "characteristic" COD values for (parameter **c** in figure 4-3) calculated by Client are shown in Table 4-4.

Table 4-4 COD Weibull Plot Characteristic Values

Paste Type	Weibull Fit Characteristic COD Values (µm)	Number of COD Data Points Plotted
PV 22A	8	8
MZ22-04	43	12
MZ22-10	28	25

Consultant understands that the number of COD data points plotted excludes test samples having COD values equal to zero. Client explained that it is not uncommon to lose electrical connection at the initiation of the crack in the silicon substrate, particularly in the PV22A samples. Consultant notes that the Weibull fit COD characteristic values are probabilistic in nature and their accuracy will depend on multiple factors. One factor is the number of data points used to calculate the Weibull fit COD characteristic value. Table 4-4 shows that the number of COD datapoints used are different for the PV22A, MZ22-04, and MZ22-10 pastes. Consultant is of the opinion that the calculated COD characteristic value of the MZ22-10 is likely closer to its true value, than the COD characteristic values of the MZ22-04 and the PV22A are to their true values.

Consultant is of the opinion that the use of Weibull analysis to estimate the COD values is consistent with accepted engineering practice. The Weibull fit characteristic value of the COD for the MZ22-04 (43 µm) is higher than those of the MZ22-10 (28 µm) and PV22A (8 µm). The Weibull fit characteristic value indicates the COD value at which approximately 63.2% of the gridlines have failed to conduct electrical current across the crack. Consultant is of the opinion that Client's data indicates that approximately 63.2% of the gridlines made using MZ22-10 would have failed to conduct electrical current across a 28 µm wide gap. Consultant is of the opinion that the data does not substantiate the datasheet statement that MetZilla paste (MZ22-10) is capable of gap-bridging cell cracks >40 µm.

Client provided Scanning Electron Microscope (SEM) images of a crack in a 2 mm wide gridline made with with a CNT-containing paste as it was being pulled apart. The image in Figure 4-4 shows the gridline metallization bridging a gap on the order of 50 µm, which is comparable to the length of individual CNTs. Client attributes this behavior to the trapping of CNTs between silver particles during the firing of the paste which strengthens the bonds between the silver particles. Client states that the CNT and silver particle clusters provide tortuous conductivity paths across gaps that are longer than the paths that the silver particles alone could create.

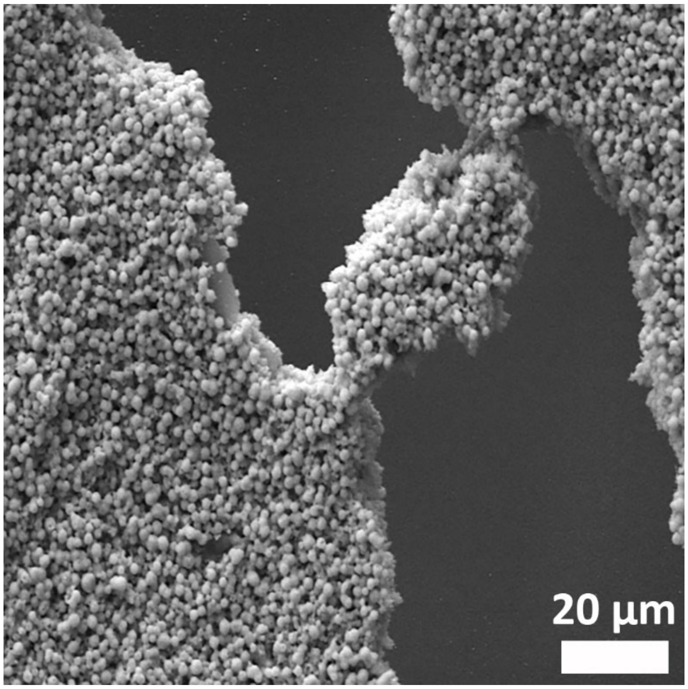


Figure 4-4 SEM Image of a Cluster of Silver Particles and CNTs Bridging a Large Gap

Client also provided SEM images of cracks in 60 µm wide gridlines printed with PV22A and MZ22-10 on PERC cells (Figure 4-5). Figure 4-5 (a) shows what appears to be a clean break of the PV22A metallization along the cell crack while Figure 4-5(b) shows the overhang of the MZ22-10 over the crack, further supporting Client's explanation of the presence of silver particle – CNT clusters. Consultant notes that the width of the crack appears to be around 20 µm and the MZ22-10 overhang appears to be on the order of 10 µm.

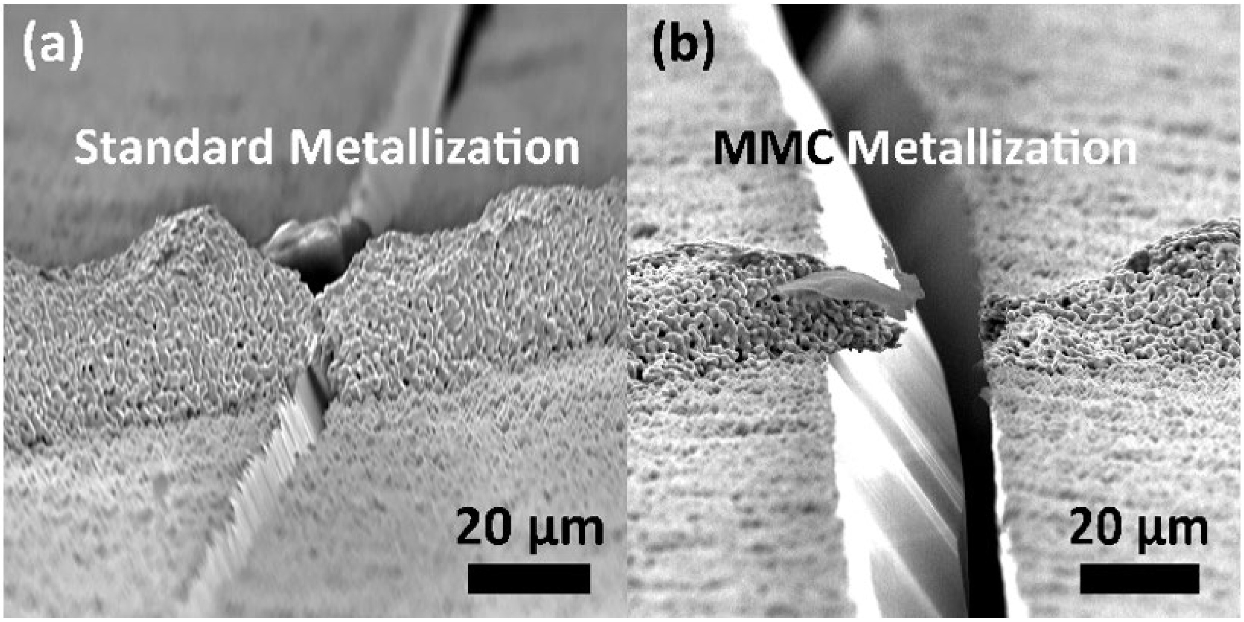


Figure 4-5 **SEM Images of Cracks in 60 µm Wide Gridline Printed with (a) PV22A (Standard Metallization) and with (b) MZZ 22-10 (MMC Metallization)**

Consultant is of the opinion that client's inquiry to explain the rationale of electrical conduction across a gap for Ag-CNT pastes is consistent with established engineering practice.

Consultant recommends that Client measure:

- Additional 60µm wide samples of to increase the confidence in the calculated Weibull fit characteristic values of COD for PV22A, MZ22-04, and MZ22-10.
- COD values on samples of PV22A, MZ22-04, and MZ22-10, 20 to 30 µm wide, which is the range of widths of gridlines on leading commercial solar cells today.

4.5 Data Sheet Statement – No Adverse Effects on Corrosion from Damp Heat, Thermal Shock and HAST

Consultant understands that Client fabricated two, two-cell (2×1) mini-modules. One of the mini-modules consisted of two Osazda Energy Mono PERC Cell G1 5BB cells manufactured using PV22A and the other mini-module consisted of two Osazda Energy Mono PERC Cell G1 5BB cells manufactured using MZ22-04. The mini-modules were fabricated and tested ae D2 Solar, a solar energy equipment supplier located in San Jose, CA. The mini-modules underwent the following tests:

- **Thermal Shock**

Client performed thermal shock testing in accordance with Joint Electron Device Engineering Council (JEDEC) reliability of packaged solid-state devices series of test methods (JESD22), thermal cycling test method (A104), revision D, modified to -70 to 120 °C for 200 cycles

- **Highly Accelerated Stress Testing**

Client performed Highly Accelerated Stress Testing (HAST) in accordance with JEDEC JESD22 unbiased HAST method A118 at 120 °C and 85% relative humidity.

Client provided the box plots of the test results for the mini-modules shown in Figure 4-6. In the box plot:

- MMC refers to the mini-module with Osazda Energy Mono PERC Cell G1 5BB cells manufactured using MZ22-04.
- D2 control refers to a D2 Solar control module (not relevant to the present analysis).
- Baseline refers to the mini-module with Osazda Energy Mono PERC Cell G1 5BB cells manufactured using PV22A.

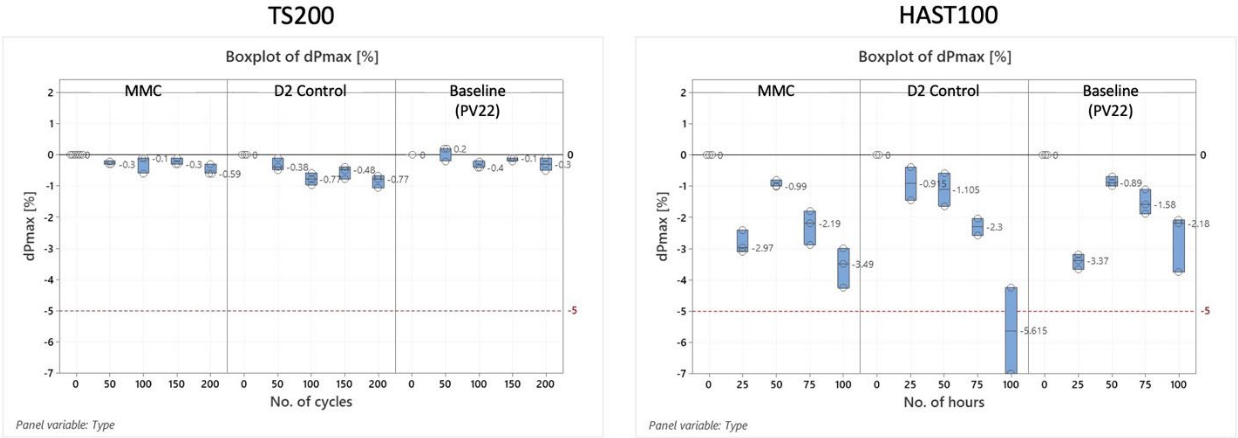


Figure 4-6 **Box Plot of Mini-Module Change in Maximum Output Power after Thermal Shock (TS) and Highly Accelerated Stress Testing (HAST)**

The MMC mini - module shows changes in maximum power output after stress testing that are comparable to those of the Baseline mini-module.

Consultant is of the opinion that the results appear to indicate that the effects leading to the decrease in maximum power output on the MMC mini-module and the Baseline mini-module after TS and HAST testing are comparable.

Consultant reviewed the Client- commissioned test report: “Mechanical, Thermal, and Humidity Stress Testing and Comparison of D2 Solar Custom Backsheet and Control Modules for Client”(CFV Solar Test Laboratory, report number 24095-PR-E-001, dated March 11, 2025) According to the CFV report, CFV Labs conducted mechanical, thermal, and humidity stress testing referencing IEC 61215-2:2021(Crystalline Silicon terrestrial photovoltaic(PV) modules - Design qualification and type approval) on a total of 10 modules produced by D2 Solar. Five modules contained Mono PERC Cell G1 5BB cells made with MetZilla (“MetZilla modules”) and the other five modules incorporated Mono PERC Cell G1 5BB cells made with PV22A (“Baseline modules”). Testing was divided into three test legs devised by CFV Labs- mechanical stress, thermal stress, and humidity stress.

The CFV report states that the changes in maximum power output after exposure to:

- 600 thermal cycles of two full-size modules manufactured by D2 Solar using MetZilla cells (OSA modules) and two full-size modules manufactured by D2 Solar using Baseline cells (Control modules) was -2.59% for the OSA modules and -1.88% for the Control modules.
- 2000 hours of damp heat of one full-size module manufactured by D2 Solar using MetZilla cells (OSA module) and one full-size modules manufactured by D2 Solar using Baseline cells (Control module) was -1.56% for the OSA module and -2.12% for the Control module.

Consultant is of the opinion that these results do not appear to indicate substantial differences in changes in maximum power output in between the OSA and Control modules after exposure to 200 thermal cycles or 2000 hours of damp heat.

The results of the testing of the two mini-modules and the three OSA and three Control modules are encouraging. Consultant recommends that Client test a larger number of modules to further substantiate the statement of no adverse effects on corrosion from damp heat, thermal shock and HAST.

4.6 Data Sheet Statement – MetZilla Paste Properties

See Section 2.2.

4.7 Data Sheet Statement – Viscosity and Fineness of Grind Match Baseline Commercial Paste

Client provided the results of viscosity measurements, performed using a Brookfield brand model DV viscosimeter (equipped with small sample adapter #14) at 20 °C. Table 4-5 shows the results for the both the baseline (PV22A) and MZ22-10 paste viscosities at different shear rates. Figure 4-7 shows a plot of these results.

Table 4-5 Viscosity Values

Rotation per Minute (RPM)	Shear Rate(/sec)	PV21A Baseline Viscosity (cP x 1000)	MZ22-10 Viscosity (cP x 1000)
20	8	160	153
30	12	115	112
50	20	80	74
60	24	70	65
100	40	48	48

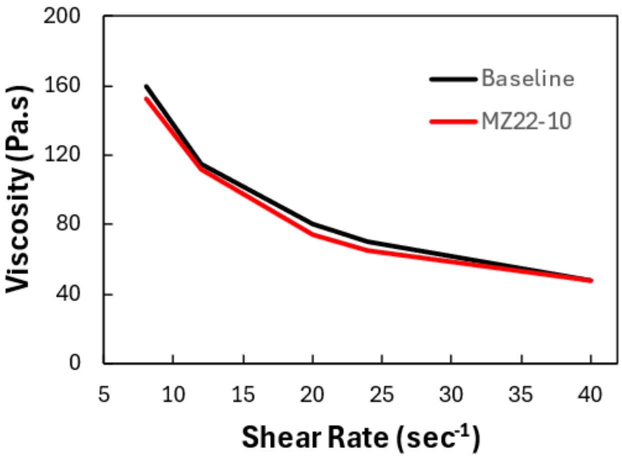


Figure 4-7 Viscosity vs Shear Rate Curve for the Baseline and MZ22-10 Pastes

As seen in Table 4-5 and Figure 4-7, the viscosity vs. shear rate for Baseline and MZ22-10 pastes are similar. Client believes that during screen printing, the Baseline and MZ22-10 pastes will spread similarly and hold their shape after application. Consultant is of the opinion that these are positive results and recommends that Client perform regular testing of MZ22-10 and Baseline pastes

Client performed side-by-side fineness of grind measurements on Baseline and MZ22-10 pastes using a Hegman gauge to determine the effectiveness of Client's mixing process and the approximate size of the CNT agglomerates in the paste. Table 4-6 shows the comparison of the fineness of grind between the baseline (PV22A) specification and the MZ22-10 measured values.

Table 4-6 Fineness Grind Comparison

Analysis Characteristic	Unit of Measure	PV22A Specification	MZ22-10 Test Value
Fineness of grind: 4th Scratch	µm	≤ 12	6
Fineness of grind: 50% Point	µm	≤ 7	4
Solids (750 °C) wt./20 min	%	90.5 ~ 92.5	91.3
Viscosity: [HBDV/#14 at 20 rpm/ 3 min] 15°C	Pa•s	170.0 ~ 350.0	232

The results show that the MZ22-10 values were well within the fineness of grind specifications for PV22A. Client believes that this indicates that the screen-printed lines using MZ22-10 paste will be similar to the lines made with baseline paste.

Consultant is of the opinion that Client should perform side-by-side batch testing of PV22A and MZ22-10 and have a third-party validate the results. Client stated that they have results from a third-party cell manufacturer on 20 µm wide gridlines in bifacial PERC cells that printed well, however Client cannot share the data due to a non-disclosure agreement.

4.8 Data Sheet Statement – Comparable Screen-Printing Performance

Client's datasheet states that MZ22-10 and PV22A pastes have comparable screen-printing performance. Consultant reviewed a summary of the screen printing of a 55 µm wide line using MZ22-10 and PV22A pastes performed by Client using a semi-manual Aremco brand screen printer and using Sefar brand screens of the same frame size, mesh count, wire diameter and angle, and emulsion type. Squeegee speed, pressure, and snap-off were adjusted based on paste viscosity for best results for both pastes. The summary of results reviewed by Consultant indicated that the print results from both pastes showed similar print line definition. However, the MZ22-10 print line showed sharper apex than the PV22A print line. Consultant also reviewed a summary of print line data where a third-party vendor printed lines using MZ22-10 and two other commercial pastes identified as EE10 and J6574. The print line widths and heights of all three pastes were comparable.

4.9 Data Sheet Statement - No Additional Steps are Required during the Printing and Firing Process

Client stated that no additional steps are required during the printing and firing of the PV22A and MZ22-10. Consultant reviewed a summary of the paste printing, drying and firing methodology provided by Client. Client explained that the drying and firing methodologies used in the manufacturing of the baseline and MetZilla cells shown in Table 4-2 were identical. Consultant is of the opinion that the results of Table 4-2 support the statement that no additional steps are required during the MetZilla printing and firing process.

4.10 Data Sheet Statement - Viscosity vs. Shear Rate Values

See Section 4.7.

5.0 High-Level Review of the Beginning of Life (BOL) Performance of Mono PERC Cell G1 5BB Cells with MetZilla and “Baseline” Mono PERC Cell G1 5BB at Different Temperatures and Irradiance

Client did not provide data to review.

6.0 High-Level Review the Results of Mechanical Stress Tests Performed by Osazda on PV Modules made with Mono PERC Cell G1 5BB with MetZilla and "Baseline" Mono PERC Cell G1 5BB to Induce Cell Cracks

Consultant reviewed the Client-commissioned test report: "Mechanical, Thermal, and Humidity Stress Testing and Comparison of D2 Solar Custom Backsheet and Control Modules for Client" (CFV Solar Test Laboratory, report number 24095-PR-E-001, dated March 11, 2025) ("the Report").

According to the Report, CFV Labs conducted mechanical, thermal, and humidity stress testing referencing international standard IEC 61215-2:2021(Crystalline Silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval) on a total of 10 modules produced by D2 Solar. The modules were 60 cell, monofacial, glass-backsheet, with an aluminum frame. Five modules contained Mono PERC Cell G1 5BB cells made with MZ22-10 ("MetZilla modules") and the other five modules incorporated Mono PERC Cell G1 5BB cells made with PV22A ("Baseline modules"). Testing was divided into three test legs devised by CFV Labs- mechanical stress, thermal stress, and humidity stress.

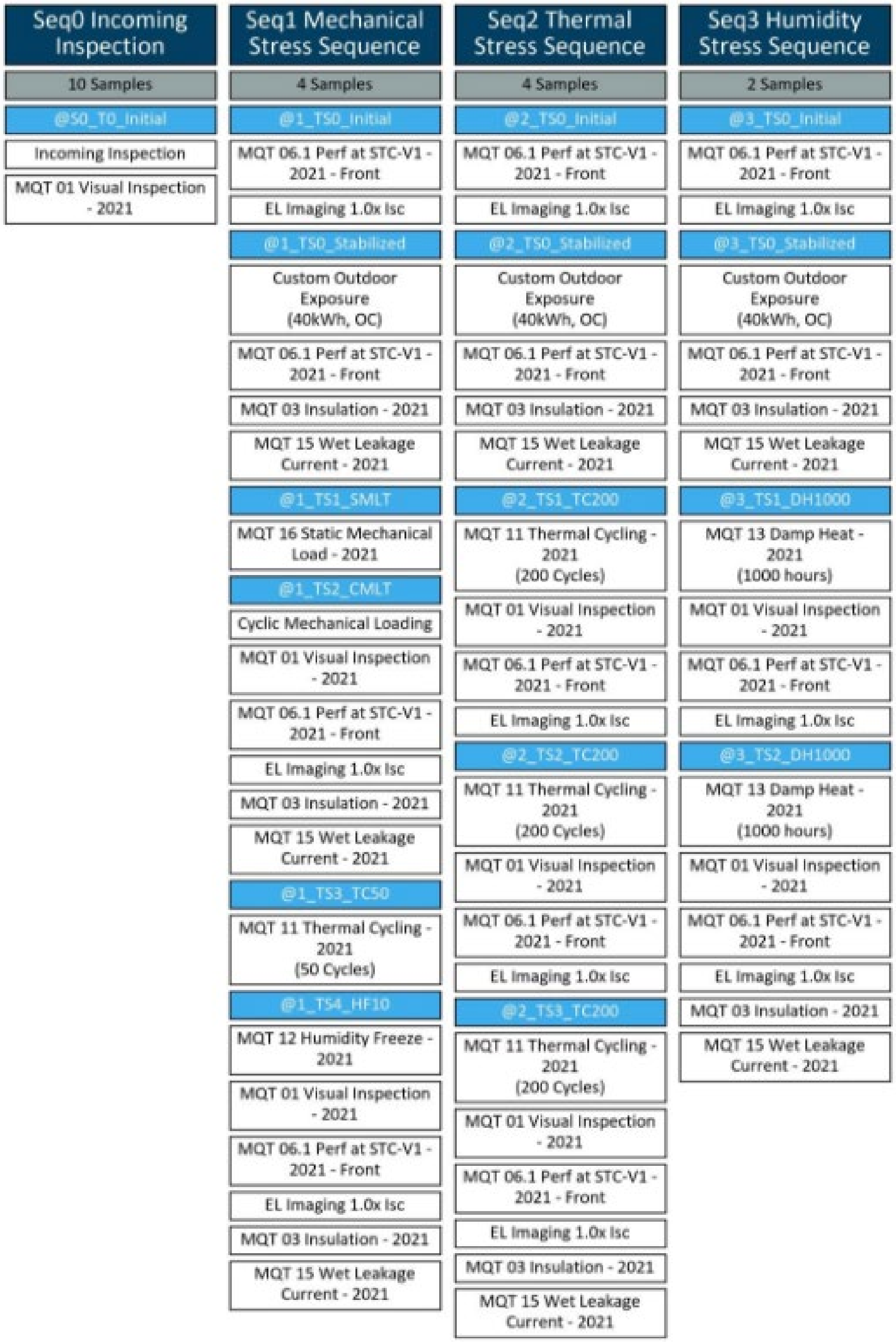
The Mechanical stress leg included:

- Static Mechanical Load testing according to IEC 61215.
- Cyclic Mechanical Load testing (not included in IEC 61215).
- Thermal Cycling (50 cycles following IEC 61215 test procedure (which is one fourth of the cycles required by IEC 61215).
- Humidity Freeze testing according to IEC 61215.

The Thermal stress leg included 600 cycles of thermal cycling following IEC 61215 test procedure. Consultant notes that 600 thermal cycles is three times the number of cycles required by IEC 61215.

The Humidity stress leg included 2000 hours of Damp Heat testing following IEC 61215 test procedure Consultant notes that 2000 hours of damp heat testing is twice the time required by IEC 61215.

The full test flow performed by CFV appears in Figure 6-1 below:



Seq0 Incoming Inspection
10 Samples
@S0_T0_Initial
Incoming Inspection
MQT 01 Visual Inspection - 2021

Seq1 Mechanical Stress Sequence
4 Samples
@1_TS0_Initial
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
@1_TS0_Stabilized
Custom Outdoor Exposure (40kWh, OC)
MQT 06.1 Perf at STC-V1 - 2021 - Front
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021
@1_TS1_SMLT
MQT 16 Static Mechanical Load - 2021
@1_TS2_CMLT
Cyclic Mechanical Loading
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021
@1_TS3_TC50
MQT 11 Thermal Cycling - 2021 (50 Cycles)
@1_TS4_HF10
MQT 12 Humidity Freeze - 2021
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021

Seq2 Thermal Stress Sequence
4 Samples
@2_TS0_Initial
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
@2_TS0_Stabilized
Custom Outdoor Exposure (40kWh, OC)
MQT 06.1 Perf at STC-V1 - 2021 - Front
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021
@2_TS1_TC200
MQT 11 Thermal Cycling - 2021 (200 Cycles)
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
@2_TS2_TC200
MQT 11 Thermal Cycling - 2021 (200 Cycles)
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
@2_TS3_TC200
MQT 11 Thermal Cycling - 2021 (200 Cycles)
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021

Seq3 Humidity Stress Sequence
2 Samples
@3_TS0_Initial
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
@3_TS0_Stabilized
Custom Outdoor Exposure (40kWh, OC)
MQT 06.1 Perf at STC-V1 - 2021 - Front
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021
@3_TS1_DH1000
MQT 13 Damp Heat - 2021 (1000 hours)
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
@3_TS2_DH1000
MQT 13 Damp Heat - 2021 (1000 hours)
MQT 01 Visual Inspection - 2021
MQT 06.1 Perf at STC-V1 - 2021 - Front
EL Imaging 1.0x Isc
MQT 03 Insulation - 2021
MQT 15 Wet Leakage Current - 2021

Figure 6-1 **Test Flow Performed by CFV Labs**

6.1 Incoming Inspection

CFV performed incoming inspection of the five MetZilla modules and the five Baseline modules according to the procedure described in IEC 61215-2:2021, MQT -01 – Visual Inspection.

6.2 Mechanical Stress Leg

CFV performed the mechanical stress leg on two MetZilla modules and two Baseline modules. Table 6-1 shows the average change in module performance parameters before and after the mechanical stress leg for the MetZilla modules and Baseline modules.

Table 6-1 Mechanical Stress Sequence Data

Module Reference	Change in Isc (%)	Change in Voc (%)	Change in Pmp (%)
MetZilla Average change	-0.20	0.11	-2.39
Baseline Average change	-1.80	-0.21	-3.53

Consultant notes that according to the Report, one MetZilla module failed wet leakage testing following cyclic mechanical loading and one Baseline module failed wet leakage testing after the ten cycles of humidity freeze testing.

Consultant notes that the MetZilla modules exhibited 1.14% less average loss in maximum power output (Pmp) than the Baseline modules.

6.3 Thermal Stress Leg

CFV performed the thermal stress leg on two MetZilla modules and two Baseline modules. Table 6-2 shows the average change in module performance parameters before and after the thermal stress leg for the MetZilla modules and Baseline modules.

Table 6-2 Thermal Stress Test Results

Module Reference	Change in Isc(%)	Change in Voc(%)	Change in Pmp(%)
MetZilla Average change	-1.53	-0.08	-2.59
Baseline Average change	-1.56	0.07	-1.88

Consultant notes that the MetZilla modules exhibited 0.71% higher loss in maximum power output (Pmp) than the Baseline modules.

6.4 Humidity Stress Leg

Table 6-3 shows the humidity stress test results for the MetZilla module and the Baseline module.

CFV performed the humidity stress leg on one MetZilla module and one Baseline module. Table 6-3 shows the average change in module performance parameters before and after the humidity stress leg for the MetZilla module and Baseline module.

Table 6-3 Humidity Stress Results

Module Reference	Change in Isc(%)	Change in Voc(%)	Change in Pmp(%)
MetZilla Module	-1.04	-0.29	-1.56
Baseline Module	-0.61	-0.33	-2.12

Consultant notes that the MetZilla module exhibited 0.56% lower loss in maximum power output (Pmp) than the Baseline module.

Consultant is of the opinion that the results of the mechanical stress and humidity stress legs indicate that the average changes in maximum power output of the MetZilla modules are smaller than those of the Baseline modules. In the thermal stress leg the average changes in maximum power output of the MetZilla modules are higher than those of the Baseline. However, given the few modules of each type that were tested definitive conclusions cannot be drawn. Consultant recommends that Client test more modules.

6.5 Electroluminescence (EL) Imaging

CFV performed EL imaging of each module before, during, and at the end of each stress leg. Consultant observed that there were small changes in the EL images of the modules before, during, and after the humidity stress and thermal stress legs. However, there were significant changes in the EL images of the modules in the mechanical stress leg. Figure 6-2 shows the EL images of the two MetZilla modules before and after the mechanical stress leg and Figure 6-3 shows the EL images of the two Baseline modules before and after the mechanical stress leg.

Consultant is of the opinion that the changes in the EL images of the MetZilla modules before and after the mechanical stress leg are less pronounced than the changes in the EL images of the Baseline modules. Consultant recommends that Client test more MetZilla and Baseline modules to confirm this different behavior and establish its root cause. If the differences in EL images between the MetZilla and Baseline modules are seen in a larger module population and are due to fewer areas of poor electrical conduction the MetZilla modules, this could be an important finding.

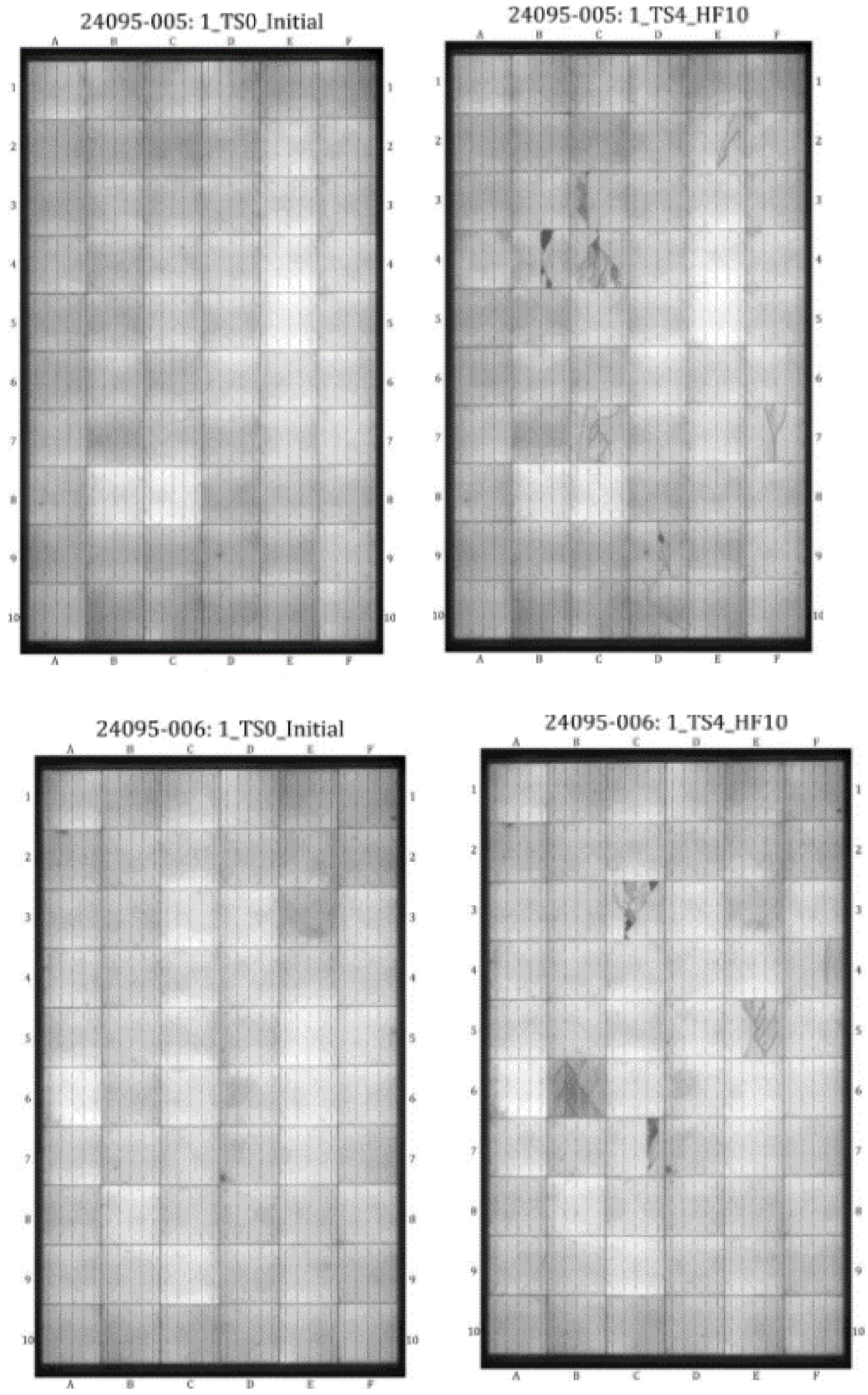


Figure 6-2 EL Images of MetZilla Modules Before and After Mechanical Stress Leg

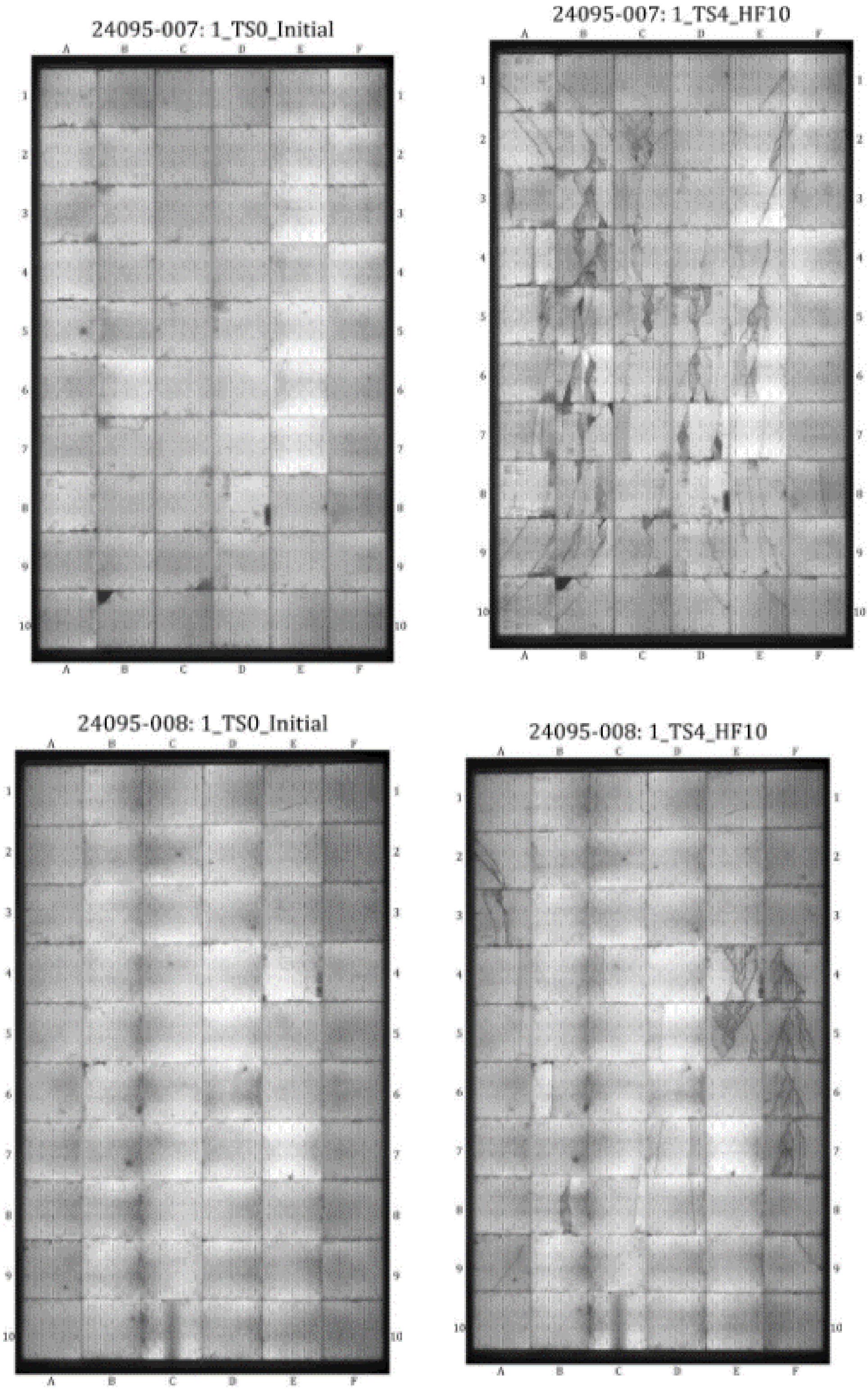


Figure 6-3 **EL Images of Baseline Modules Before and After Mechanical Stress Leg**

BLACK & VEATCH | High-Level Review the Results of Mechanical Stress Tests Performed by Osazda on PV Modules made with Mono PERC Cell G1 5BB with MetZilla and "Baseline" Mono PERC Cell G1 5BB to Induce Cell Cracks 6-6
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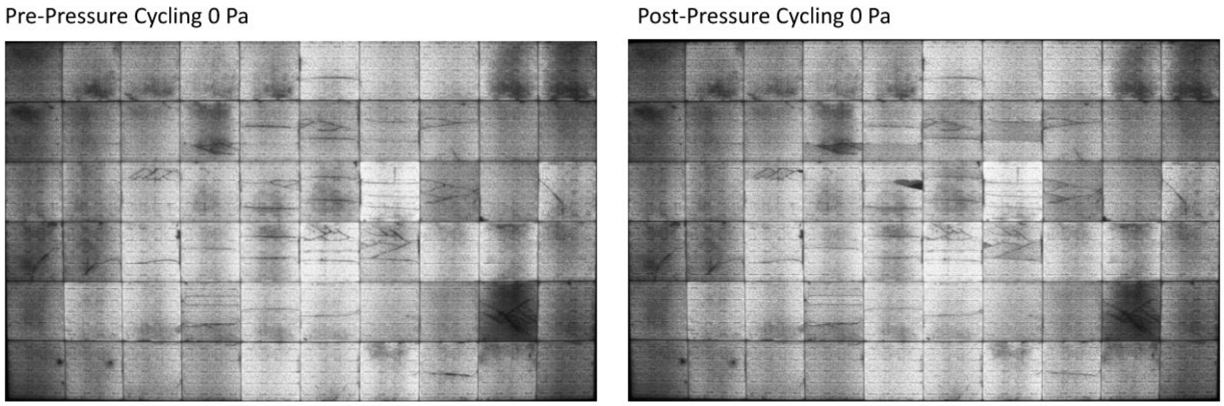
6.6 Pressure Cycling Tests by Sandia National Labs

Consultant reviewed a summary of the pressure cycling results performed by Sandia National Labs on two Osazda-provided modules. The summary provided to Consultant showed pre- and post- pressure cycling EL images of each module for the following pressure cycling sequences:

- Module OSA-24-001 PV22 (Baseline module)
    - 500 cycles +/- 500 Pa
    - 1500 cycles +/- 500 Pa
    - 1500 cycles +/- 500 Pa; 500 cycles +/- 1000Pa
- Module OSA-24-002 MV22 (MetZilla Module)
    - 500 cycles + 80Pa /- 500 Pa
    - 1500 cycles + 80Pa/+ /- 500 Pa
    - 1500 cycles + 80Pa/+ /- 500 Pa; 500 cycles +/- 1000 Pa Cycles

EL images of the Baseline Module before and after 500 cycles +/- 500Pa appear in Figure 6-4.



Pre-Pressure Cycling 0 Pa

Post-Pressure Cycling 0 Pa

Figure 6-4 EL Images of Baseline Module Before and After Pressure Cycling (500 cycles +/- 500Pa)

Consultant observed that all the Sandia National Labs pressure cycling EL images for the Baseline module showed many defects. However, the defect pattern did not appear to change significantly before and after the pressure cycling sequences.

EL images of the MetZilla Module before and after 500 cycles +/- 500Pa appear in Figure 6-5.

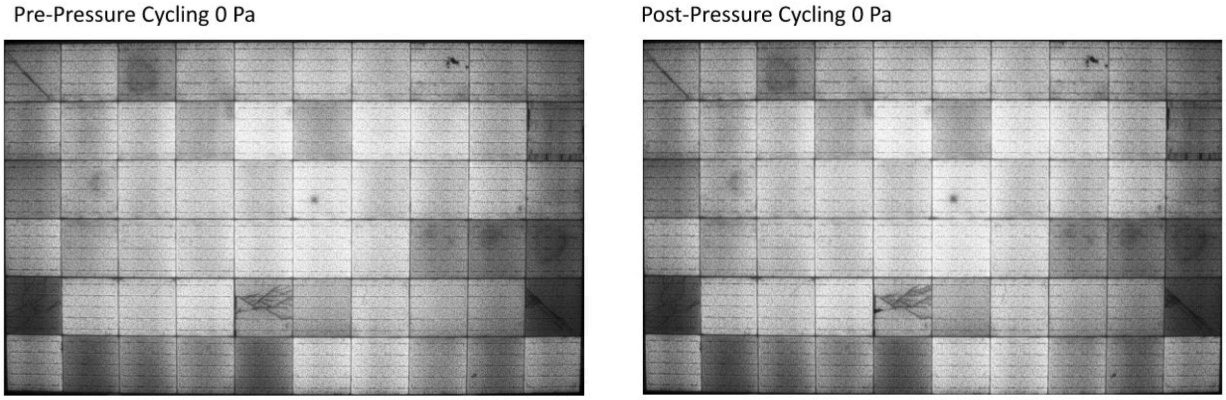


Figure 6-5 **EL Images of MetZilla Module Before and After Pressure Cycling (500 cycles +/- 500Pa)**

All the Sandia National Labs pressure cycling EL images for the MetZilla module showed fewer defects than the Baseline Module and the defect pattern did not exhibit significant changes before and after the pressure cycling sequences.

Given the significant differences in the EL images of the Baseline and MetZilla modules prior to pressure cycling Consultant refrains from drawing conclusions on the effects of pressure testing on the Baseline and MetZilla modules other than the observations made above.