



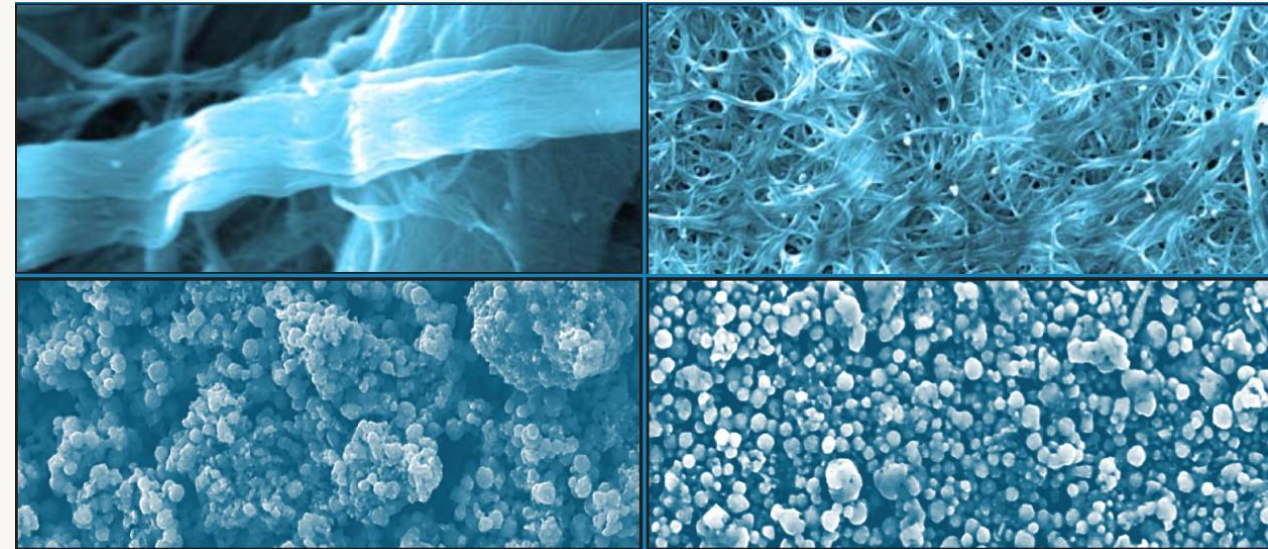
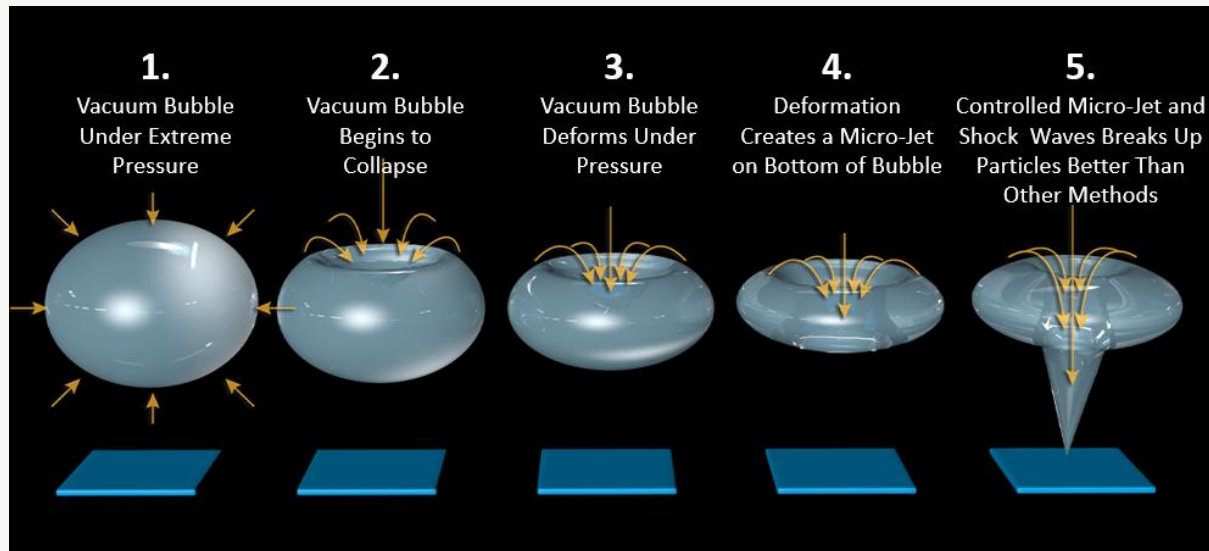
Silver metallization for solar cells

Dana Hankey

ACI Materials

Cavitation and ACI's origins

Better dispersion helps materials deliver their optimum performance.



Before cavitation

After cavitation

Controlled bubble collapse creates localized energy that separates particle agglomerates.

Experience in demanding applications

Aerospace coatings and conductive inks

10+ years of flight heritage

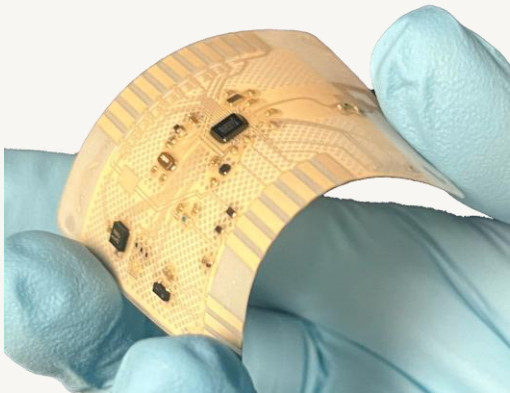
Meeting performance requirements within narrow processing and operating conditions



Printed Electronics

ACI's solderable ink system enables additive electronics manufacturing.

Circuit Boards



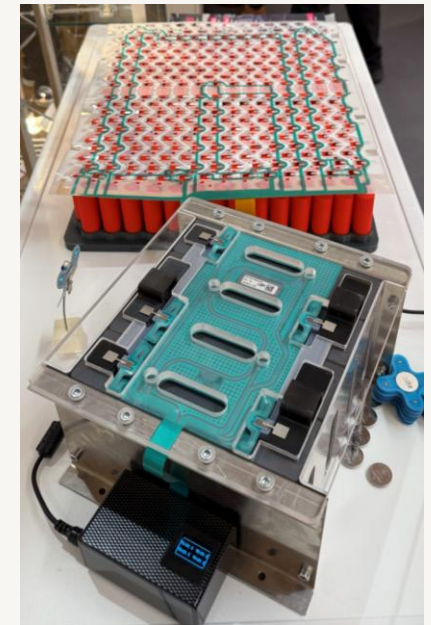
Acoustic Sensors



Pressure Sensors



Battery Management



Returning to solar



We improved the base formulation and have been verifying data with Dr. Ebong's lab at UNC Charlotte.

Why now

Changed market conditions have renewed our focus on solar metallization.

What we are improving

Paste performance within the customer's printing and firing window.

The goal is improved cell performance and enabling consistent cell efficiency in production.

1. Intal, D., Ebong, A., Hankey, D., & Tibbetts, M. (2024). Cavitated Ag paste for cost-effective solar cells. *AIP Advances*, 14(8).
2. Ebong, A., Intal, D., Huneycutt, S., Imhof, H., Stephenson, R., Hankey, D., & Tibbetts, M. (2023, December). The Prospect of Cost Reduction in the Metallization of Crystalline Silicon Solar Cells by Alternative Metal Contacts-Ag Coated Cu Paste. In *2023 IEEE 20th International Conference on Smart Communities: Improving Quality of Life using AI, Robotics and IoT (HONET)* (pp. 101-104). IEEE.
3. A. Ebong et al., "The Prospect of Cost Reduction in the Metallization of Crystalline Silicon Solar Cells by Alternative Metal Contacts - Ag Coated Cu Paste," *2023 IEEE 20th International Conference on Smart Communities: Improving Quality of Life using AI, Robotics and IoT (HONET)*, Boca Raton, FL, USA, 2023, pp. 101-104, doi: 10.1109/HONET59747.2023.10375015

Balancing the formulation

Electrical contact

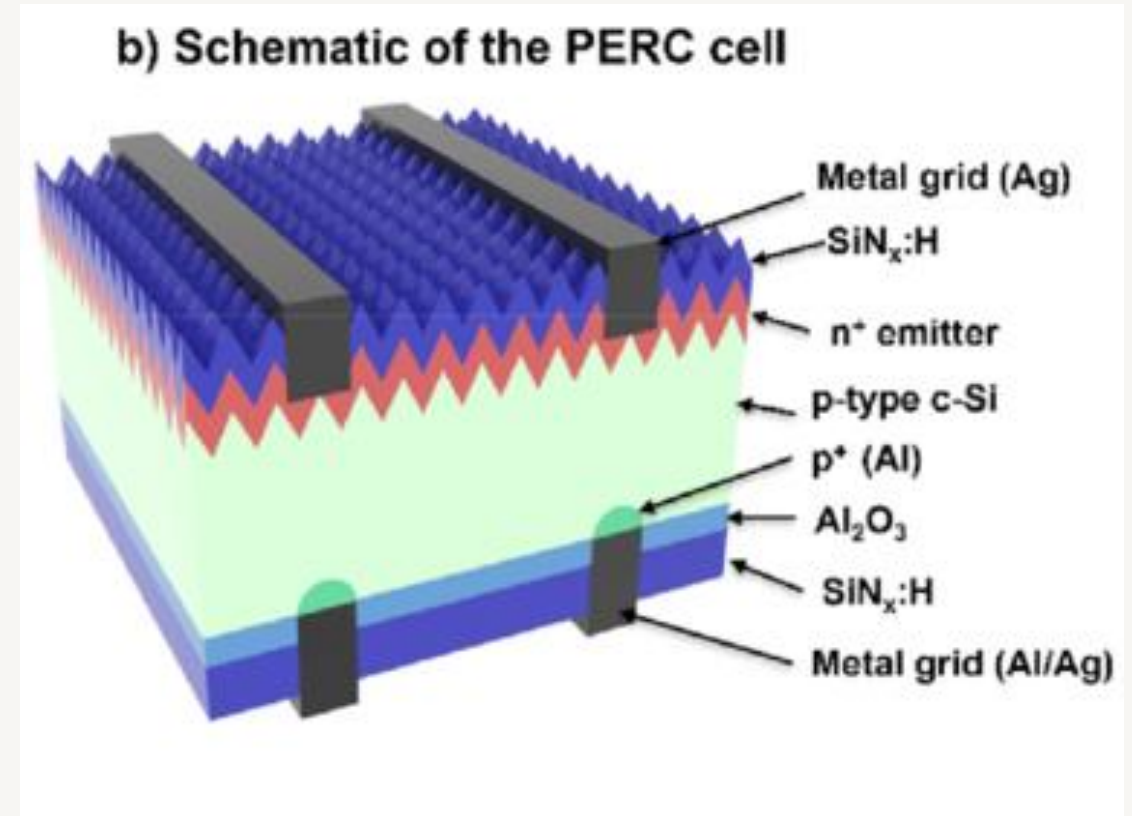
Optimum dispersion of the glass enables more uniform contact to the emitter layer coating.

Current collection

Dense particle packing, enabled by cavitation, forms a highly conductive network when fired.

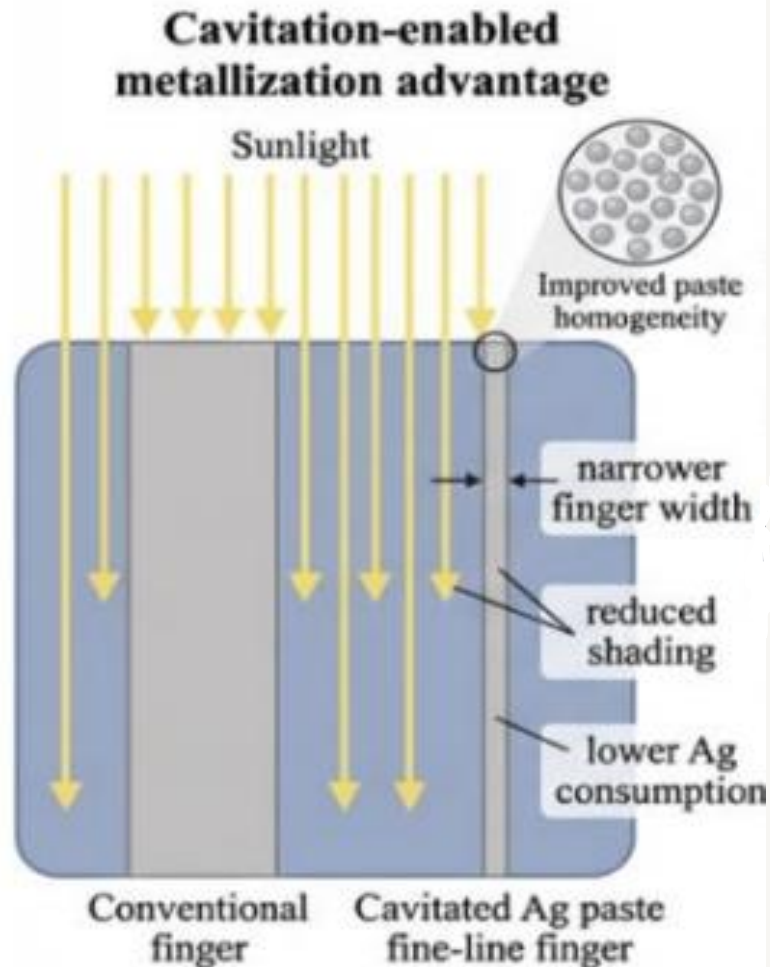
Printed geometry

Fine lines must limit shading and retain their shape.



PERC cell architecture

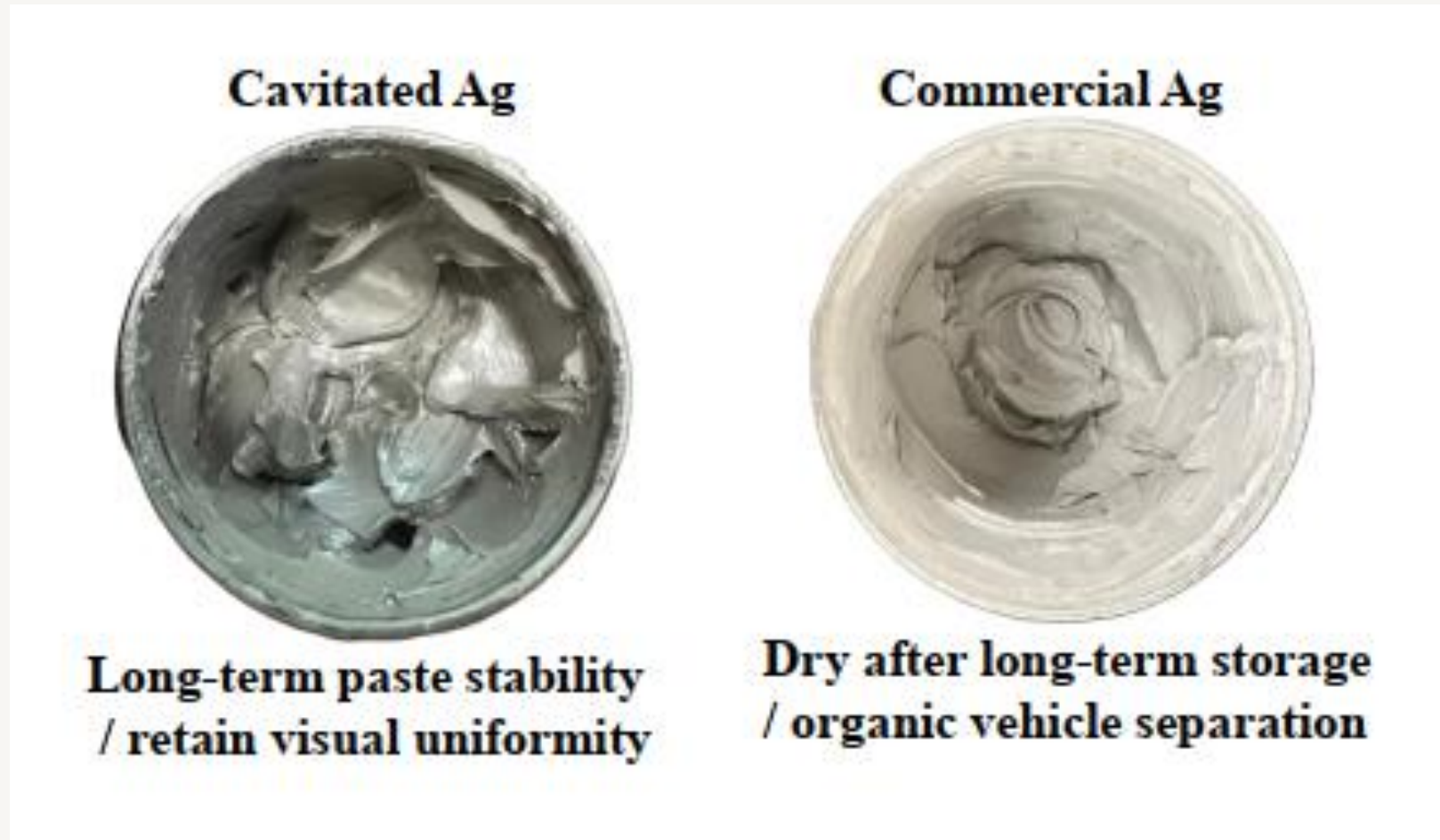
The ACI Advantage



ACI's Cavitated metallization paste provides:

- Superior particle top-size control, which enables fine line printing.
- Higher bulk conductivity, which reduces silver consumption.
- Improved rheological properties, which remain stable over time.

Stability over time



Visual storage comparison. Storage duration and conditions are not specified.

Printing, firing and post-processing

Printing

Screen release
Line definition
Controlled spreading



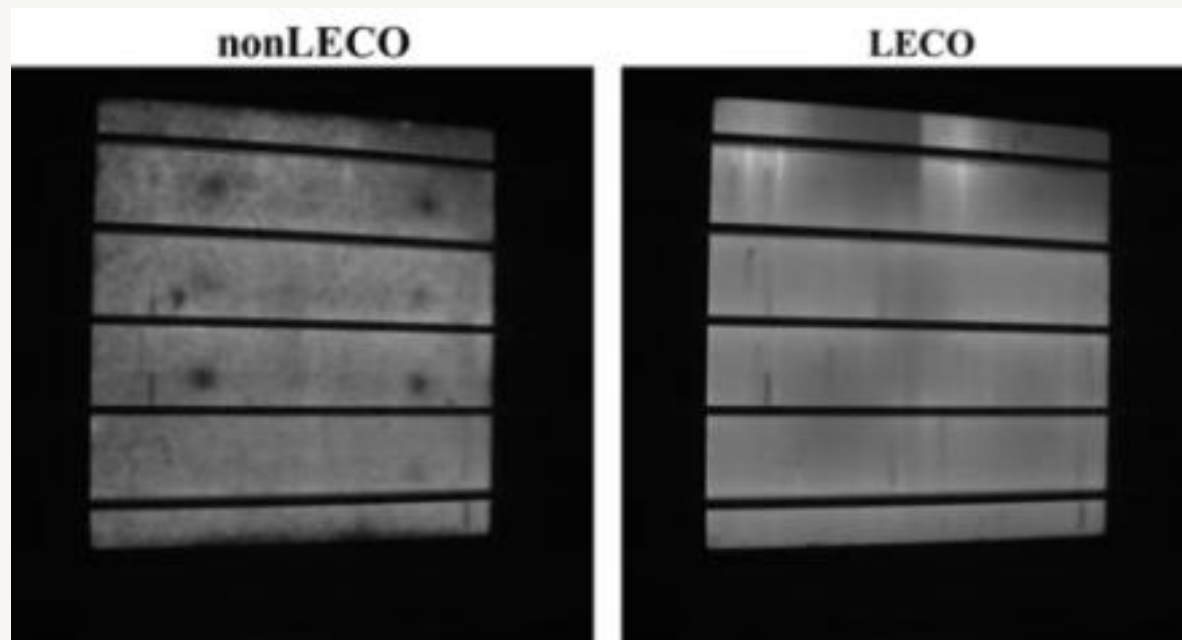
Firing

Organic removal
Contact formation
Silver sintering



LECO

Original Ink Evaluation



Current Ink Evaluation



90-finger results and a 120-finger scenario

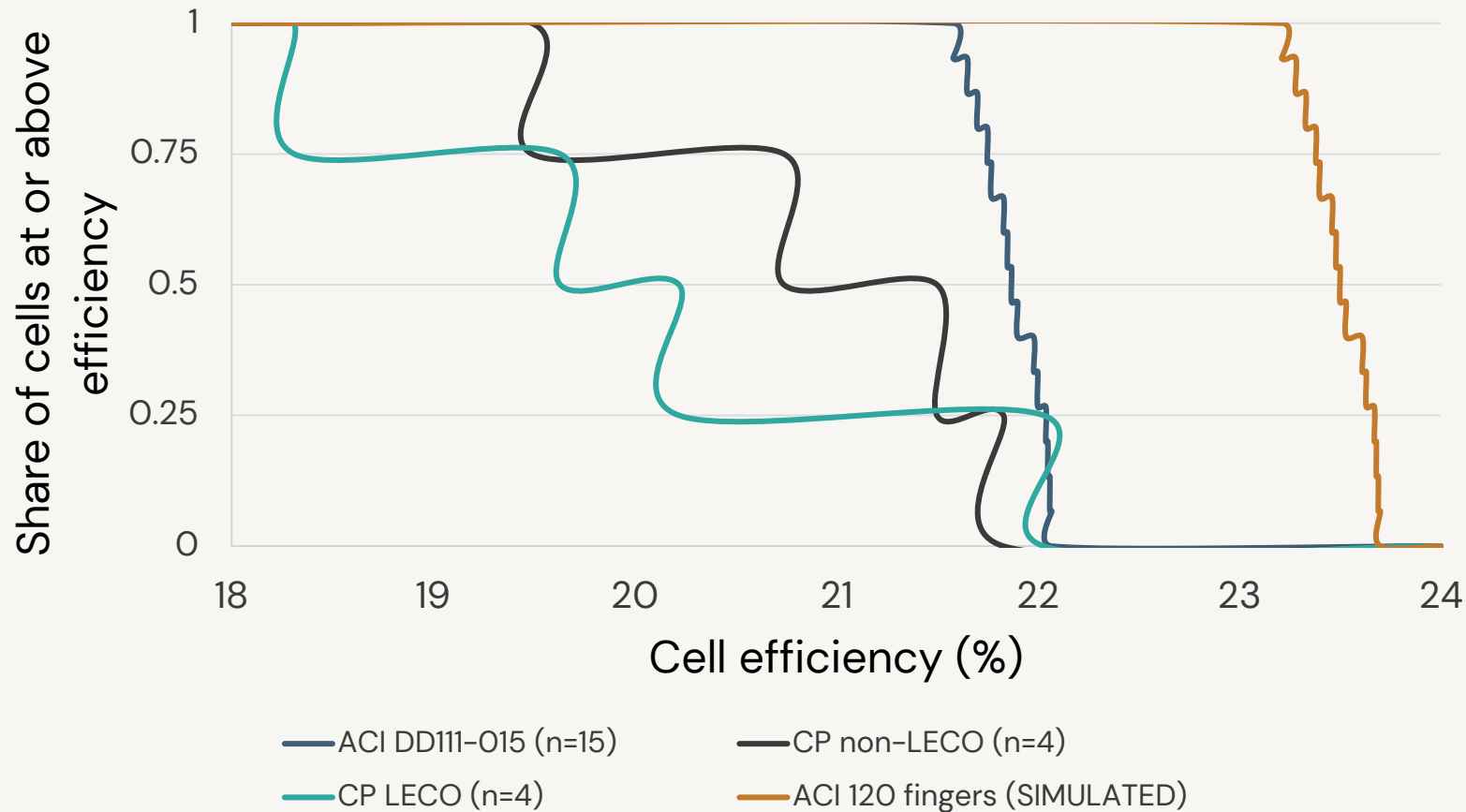
Efficiency result	ACI DD111-015 90 fingers Measured	CP 90 fingers non-LECO	CP 90 fingers LECO	ACI 120 fingers SIMULATED
Cells / model values	15 measured	4 measured	4 measured	15 modeled
Mean efficiency	21.87%	20.89%	20.05%	23.50%
Mean fill factor	79.98%	75.12%	72.12%	79.98%
Efficiency SD ¹	0.16 pp	1.04 pp	1.54 pp	0.16 pp
Efficiency range	21.58–22.07%	19.49–21.83%	18.31–22.03%	23.21–23.70%

Simulation: add 1.63 percentage points to each ACI result.
The spread stays unchanged by assumption. This is not a forecast.

¹ pp = percentage points. A mean of 23.50% with a standard deviation of 0.16 pp puts one standard deviation below and above the mean at 23.34% and 23.66%.

Initial lab comparison. CP = Commercial Paste. ACI's measured LECO status is not specified.

Efficiency distribution and customer value



Measured at $\geq 21.5\%$

15 / 15 ACI Paste
2 / 4 Commercial Paste non-LECO
1 / 4 Commercial Paste LECO

120-finger scenario

23.50% mean
23.21–23.70% range
7 / 15 modeled values above 23.5%

Simulation adds 1.63 percentage points to ACI's measured values. Spread unchanged by assumption; not a forecast.



Customer qualification and next steps

Additional Screen Pattern Testing

Test the updated paste on 120-finger pattern. Confirm performance across repeated lots.

Customer sampling

Agree on printing and firing conditions, qualification lots and acceptance criteria.

Let's discuss your process and the performance you need.

Dana Hankey

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