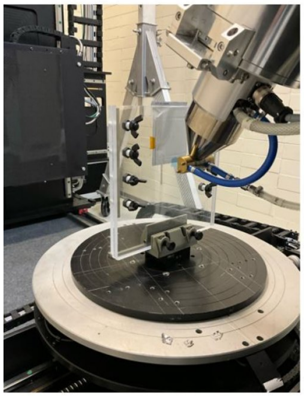
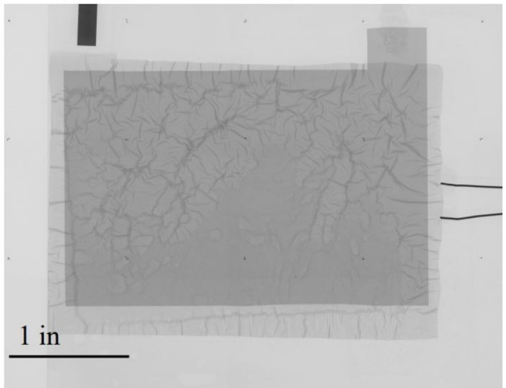
National Aeronautics and
Space Administration





TECHNOLOGY SOLUTION

Optics

Fingerprinting for Rapid Battery Inspection

Time-saving approach to enable battery dendrite detection

Dendrite growth in lithium-ion batteries can lead to fires and explosions, limiting battery life and safety. High resolution radiographs can be used to detect subtle precursors to battery failure, but it can be tedious to collect and combine these radiographs over the course of testing many battery samples.

NASA researchers developed a novel technique for creating unique orientation fingerprints on battery samples prior to digital radiograph collection. The fingerprints enable rapid assembly of high-resolution images. This allows efficient inspection of batteries for early signs of dendrite formation, improving safety and extending useful battery life. This technology can improve efficiency in battery R&D, battery production, and other electronics applications.

BENEFITS

- Improve battery designs to increase safety: Enables detection of dendrite formation, enabling battery design to better mitigate battery failure
- Efficient battery R&D: Assembles image mosaics nearly automatically (~5-minutes), drastically saving time compared to repeatedly manually stitching ~20 high-res image tiles over successive tests
- Low-energy dosing: As the technology works at the low operating limit of radiography equipment, the risk of negative impact of x-rays on the underlying materials is low
- Streamlined production quality control: Implemented at scale, the technology can support detection of folds or tears in separator material viewable via radiography

APPLICATIONS

The technology has several potential applications:

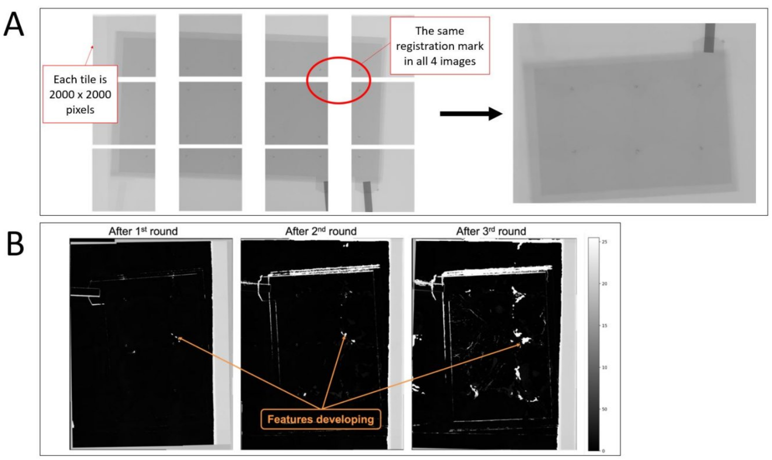
- Battery R&D: Accelerate evaluation of cell chemistries and constructions
- Battery Production: Enable high-throughput quality inspection during manufacturing
- Battery field monitoring: facilitate assessment of battery health after deployment
- Electronics manufacturing: Adaptable to inspection of components like semiconductors or composites requiring high resolution and throughput inspection

THE TECHNOLOGY

The technology utilizes photopolymer droplets (invisible to the digital radiograph) with embedded radiopaque fragments to create randomized fingerprints on battery samples. The droplets are deposited using a jig (see figure on right) that precisely positions samples. Then, at different points during battery R&D testing or use, digital radiography imaging with micron-level resolution can be performed.

The high-resolution imaging required to detect dendrite formation requires images to be collected in multiple “tiles” as shown below. The randomized fingerprints uniquely identify relative positioning of these tiles, allowing rapid assembly of composite high-resolution images from multiple tiles.

This same composite creation process can be used for images taken at a series of points in time during testing, and background subtraction can be applied to efficiently compare how the battery is changing over successive charge/discharge cycles to identify dendrite formation. This inspection technique is proven effective for thin-film pouch cell prototypes at NASA, and it works well at the lowest available x-ray energy level (limiting impact on the samples). The Fingerprinting for Rapid Battery Inspection technology is available for patent licensing.



(A) High-resolution tiled digital radiographs can be composited based on this fingerprinting approach. (B) Moving from left to right, changes in digital radiographs of an example pouch-cell battery are shown after the battery underwent three rounds of charge-discharge testing.

(Top) 3D-printed jig for placing small sections of magnet wire into photopolymer droplets on the surface of a pouch cell. Paper inserts prevent wire from adhering electrostatically to the jig. (Bottom) Sections of magnet wire within a single droplet.

PUBLICATIONS

Automated registration of multi-mode nondestructive evaluation data. Spaeth, et al. 2023. https://ntrs.nasa.gov/citations/20230001996

More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Langley Research Center

Mail Stop 020
Hampton, VA 23681
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

NP-2023-11-3194-HQ

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LAR-20275-1, LAR-TOPS-378