SemiSolid™ Electrode The Next Generation Product & Manufacturing Platform

Jan 2023

Company Overview & Partners

About 24M

- 2010: company spun out of MIT
  - Yet-Ming Chiang, Throop Wilder, W. Craig Carter
  - SemiSolid™ platform drives massive operating &capital savings
- 2014: automated line running
  - 32,000 ft² facility in Cambridge, Massachusetts
  - More than 3000 formation channel, 5000 Ft2. dry room, Safety Test Room, etc.
- 2019: low-cost manufacturing commercially proven
  - Kyocera's Japanese factory starts cell production for residential solar + storage prod.
  - GPSC/PTT started plant construction
- 2020: commercial engagements accelerate
  - GPSC/PTT completed factory construction in late 2020
  - AXXIVA and FREYR signed licensing and service agreement
- 2021: execution of production launch with partners
  - Lucas TVS, KOCH-FRYER, VW group signed licensing and service agreement
  - Support commercial scale production setup and launch with multiple partners
- 2022: solid growth with resource expansion
  - Fujifilm signed licensing agreement
  - Continue strong support to partners on production plant launch
- Strong IP Fortress
  - **160+ issued patents, 160+ pending**
- Funding:
  - From highly reputable industrial partners, financial investors,
  - US Government Support: **3 ARPA-E, USABC, VT Funding programs**

Recognition

WORLD ECONOMIC FORUM

Technology Pioneers

Global Cleantech 100

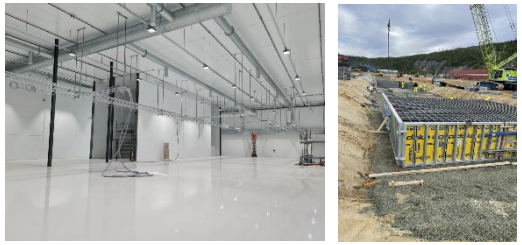
cleantech theguardian

NEW ENERGY PIONEER 2016 Bloomberg NEW ENERGY FINANCE WINNER SPONSORED BY CYCLE CAPITAL MANAGEMENT

2016 PLATTS GLOBAL ENERGY AWARDS FINALIST

24M Current Global Licensing Partners

- 24M's platform and products have been commercialized by our global licensing partners
- New manufacturing plants are being constructed in various regions



Confidential

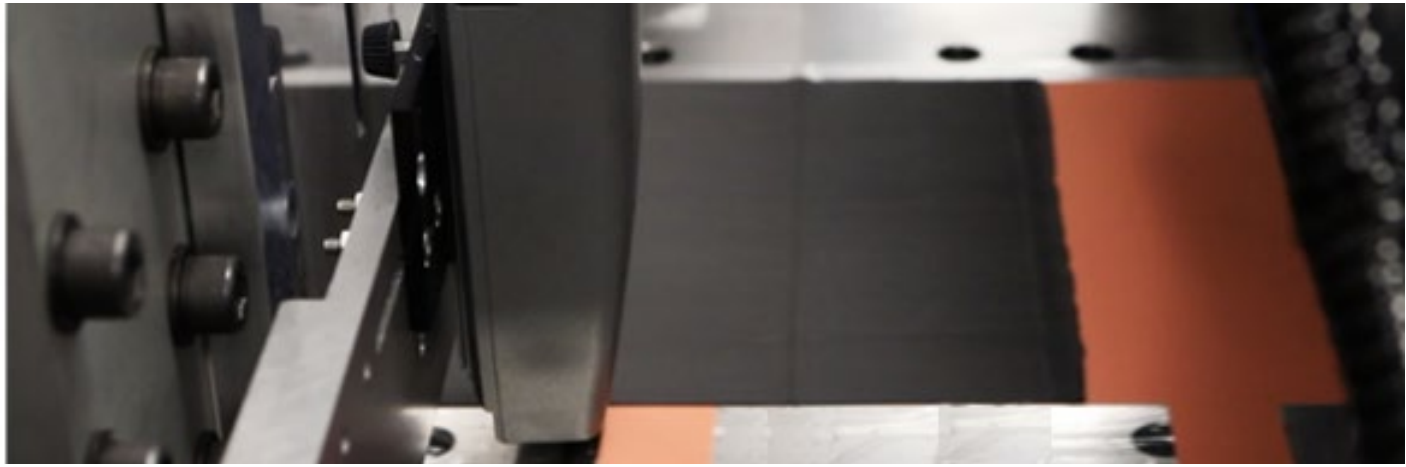
Company Technology and Competitive Advantage

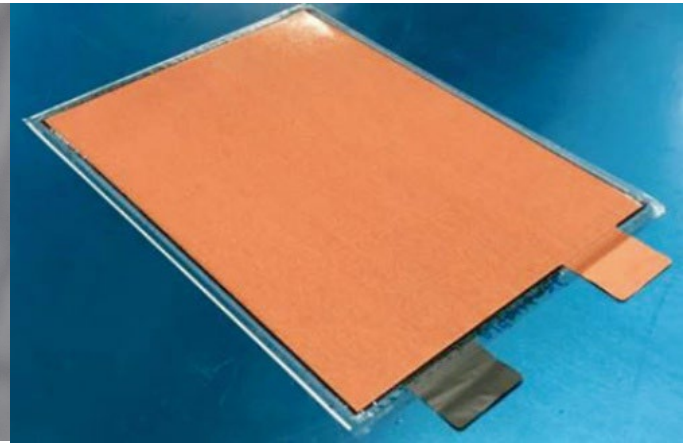
SemiSolid™ Electrodes – Reinventing the Lithium Ion Manufacturing Platform

- The simplicity of the SemiSolid™ manufacturing platform provides a robust, chemistry-agnostic foundation for industry-leading price/performance

- 24M's proprietary SemiSolid™ platform provide.
  - **Thick binder free / deformable electrode**
  - **Single Pouch Structure**
  - **Electrolyte mixing in the beginning.**

Direct casting of binder free slurry on copper foil





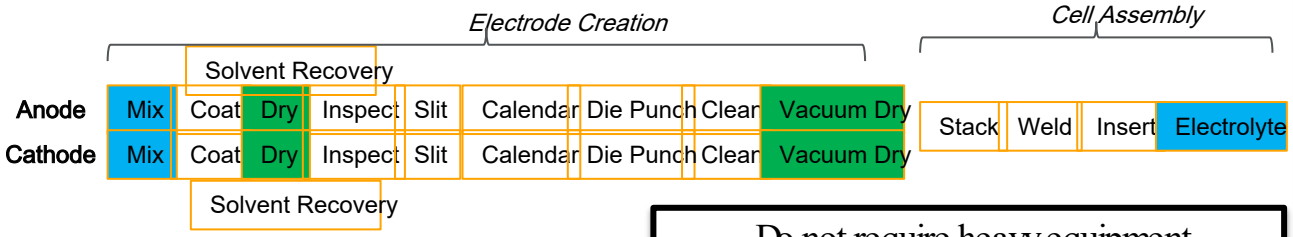
24M licenses patent protected SemiSolid™ manufacturing and product platform for sustainable growth of lithium rechargeable batteries and cleantech energy.

25-40% Cost reduction of Li-Ion Batteries by SemiSolid∑Platform

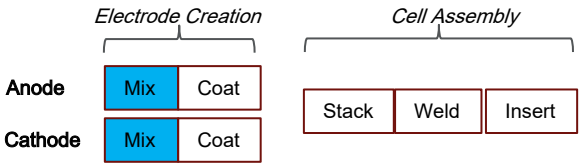
Simplified Process

24M has better capital efficiency (lower Capex and lower operating costs because we use less equipment, labor, energy, space, and time

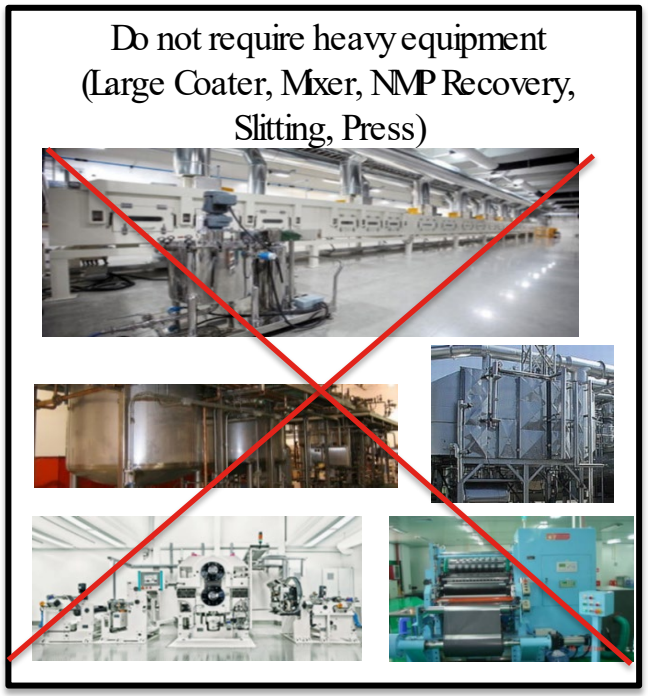
CONVENTIONAL 13 Steps



24M 5 Steps



Do not require heavy equipment (Large Coater, Mixer, NMP Recovery, Slitting, Press)

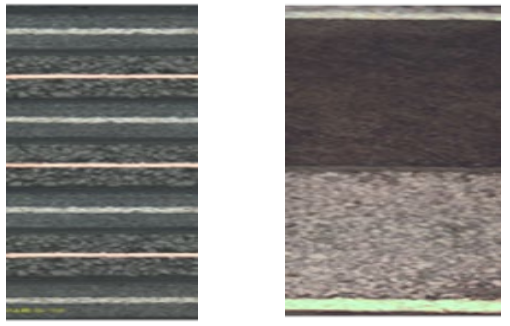


Thick Electrodes

24M has a structural Bill of Materials cost advantage bec thick electrodes require less inactive material (copper, alu separator) and no binder

CONVENTIONAL **24M**

1mm Cross Section of Cells



2-3mAh/cm2 VS ~13mAh/cm2

60-110 microns VS ~500 microns

25 to 40% BOM Cost Reduction.

Components		24M BOM Advantage Conventional	24M
Cathode	LFP	100%	—
	Carbon	100%	—
	Binder	100%	-100%
	Electrolyte	100%	-4%
	Al. Foil	100%	-61%
	NMP	100%	-100%
Anode	Graphite	100%	—
	Carbon	100%	—
	Binder	100%	-100%
	Electrolyte	100%	-12%
	Copper foil	100%	-63%
Package	Separator	100%	-82%
	Pouch	100%	-10%
	Tab/Tape	100%	-10%
TOTAL:		100%	-25 to 40%

Unit Cell Architecture Improves Product/Process Reliability

24M Single Unit Cell Design (Patented)

Thin Plastic Film

– Plastic Film Structure –
Commonly used in food packaging industry

- **Prevention of internal metal contaminations**
  - Eliminate contaminations from *Electrode Slitting*
  - Eliminate contaminations from *Tab Welding*
  - Eliminate contaminations from *Can Crimping*
- **Eliminate unit cell *misalignment* short circuit failure**
  - Separator sealed to outer film
- **Eliminate stack cell *misalignment* short circuit failure**
  - Electrode insulated by outer film
- **100% traceable in production process**

Potential catastrophic failure eliminated by design

SemiSolid Electrodes – A New Platform for Lithium-Ion Manufacturing

Core Technology

1. Low Cost (①, ③)
   - Structural BOM advantage
   - Simplified manufacturing process
2. Product/Process Reliability (①,②,③)
   - Metal contamination control
   - Electrode short circuit control
3. Product Safety (①,②)
   - Hazard level #1 in crush
   - Hazard level #2 in overcharge
4. Recyclability (①)
   - Direct recycling
   - Eliminate in process yield loss
5. Lower System Costs with Large Cell Designs (①,③)
   - GridBox/GridBlock
   - Series / Parallel connection inside package

Future Performance

1. Silicon Electrode (①, ③)
   - Reduced volume expansion of silicon electrode
2. Pre-Lithiation (③)
   - Simple implementation of pre-lithiation
3. Lithium metal battery development (①, ③)
   - Reduction of Cu foil with thick SemiSolid cathode improves Wh/kg significantly
4. Dual Electrolyte System(①,②,③)
   - High energy/long life cell design
   - Separately optimize catholyte and anolyte for differentiated performance

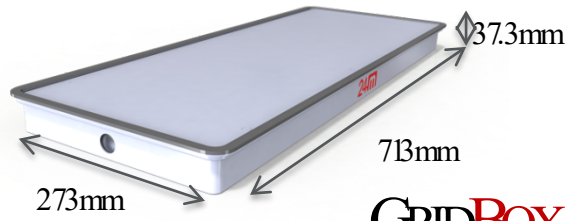
① Thick binder-free / deformable electrode
② Single Pouch Structure
③ Electrolyte mixing in the beginning.

SemiSolid∑ Platform Offers Unique Opportunities

Crush Safety / Deformable

Unique mechanical abuse performance attributed to SemiSolid∑ Electrodes.

Large Format

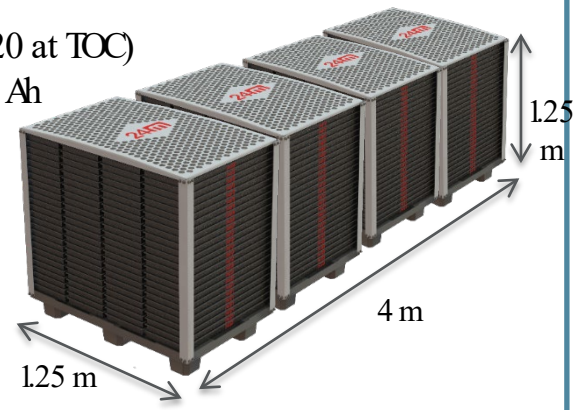


GRIDBOX

3.2 V, 500 Ah,
1.6kWh, 50 Unit Cells

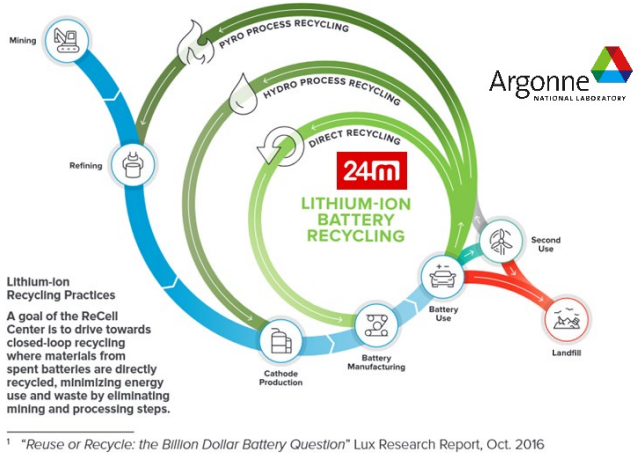
GRIDBLOCK

1280 V (1520 at TOC)
500 Ah



Fill-less process allows for easy creation of large-format cells and reduction of balance of module/ system cost

Recycling



[1] *"Reuse or Recycle: the Billion Dollar Battery Question"* Lux Research Report, Oct. 2016

Binderless electrodes offer unique opportunity for reuse/recycling

SemiSolid™ platform advantages apply to any cell chemistry

Summary

Summary

- **Differentiated today: 24M SemiSolid technology offers next generation Li-ion manufacturing platform**
  - > Much lower cell cost via reduced bill of materials and simplified manufacturing process ($/kWh)
  - > Much lower the capital cost per unit of manufacturing capacity installed ($/MWh)
  - > Higher safety & reliability rating, environment friendly and fully recyclable

- **Transformation tomorrow: SemiSolid platform enables unique approaches to high performance**
  - > Rapidly scale up new technologies by integrating into existing 24m high volume manufacturing processes
  - > Leverage differentiated silicon anode approach to move to 1st position in high energy density systems
  - > Semi-Solid cathode coupled with Lithium metal anode in single pouch format shows significant advantages

- **Commercialization underway: Strategic partners building factories to exploit today's technology**
  - > 24M's SemiSolid™ platform has been commercialized by in Asia since late 2020
  - > Other global licensed partners are at various commercialization deployment phases
  - > Multiple tens of GWh of production capacity is expected to come online from 2023 and on