Development of Roll-to-Roll Simultaneous Multilayer Deposition Methods for Solid-State Electrochemical Devices Using Highly Particulate Loaded Aqueous Inks

Contract Number DE-AC05-00OR22725
Saint-Gobain High Performance Material & Oak Ridge National Laboratory
Project Period: August 1, 2018 – July 31, 2020

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Overview

Timeline:

- Project Start: August 1, 2018
- Project End: July 31, 2020

Budget:

		Period 1 2018-2019	Period 2 2019-2020	Total
Project Cost	SG	$ 577,383	$ 410,561	$ 987,944
	ORNL	$ 35,000	$ 40,000	$ 75,000
	Total	**$ 612,383**	**$ 450,561**	**$ 1,062,944**
Cost Share		$ -122,493	$ -90,098	$ -212,591
DOE funded		**$ 489,890**	**$ 360,463**	**$ 850,353**

Barriers

- Key risk factors identified
- Contingency & mitigation strategies tabulated

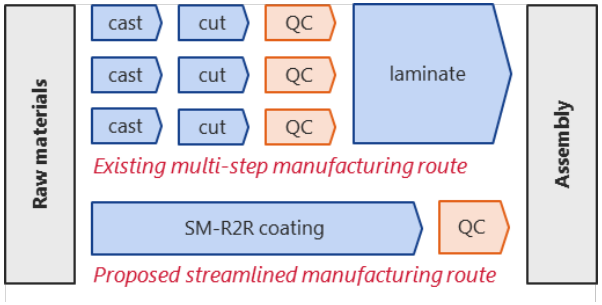
Partners

- Saint-Gobain:
  - Project management
  - Ink Formulation & Coating
  - Application Testing
  - Industrialization
- Oak Ridge National Lab:
  - Techno-economic Analysis
- Advisory Board:
  - Technical & Market Guidance

Project Objective(s)

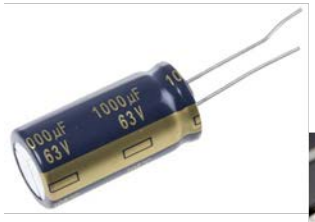
Project aims to

- lower production cost,
- increase performance, and
- reduce lifecycle energy consumption



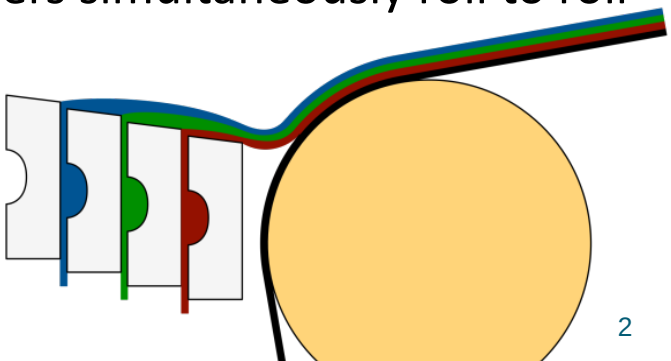
Devices commonly cast from highly particulate loaded aqueous inks

- Fuel cells
- Lithium-ion batteries
- Photovoltaics
- Capacitors



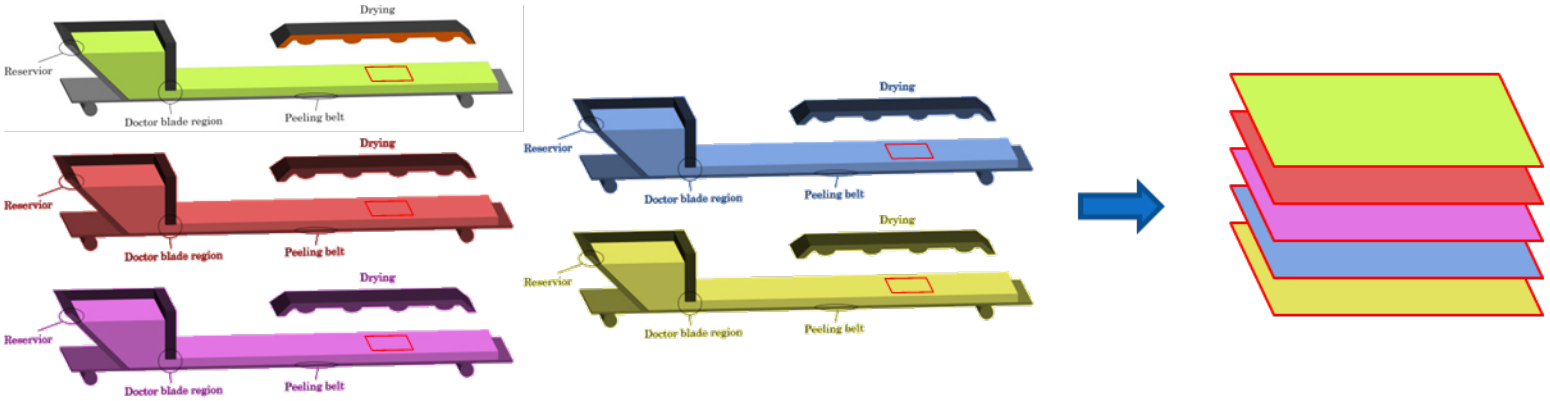
Technical objective

- Fabricate & characterize devices cast with up to 6 layers simultaneously roll to roll
- Evaluate potential benefit for various applications

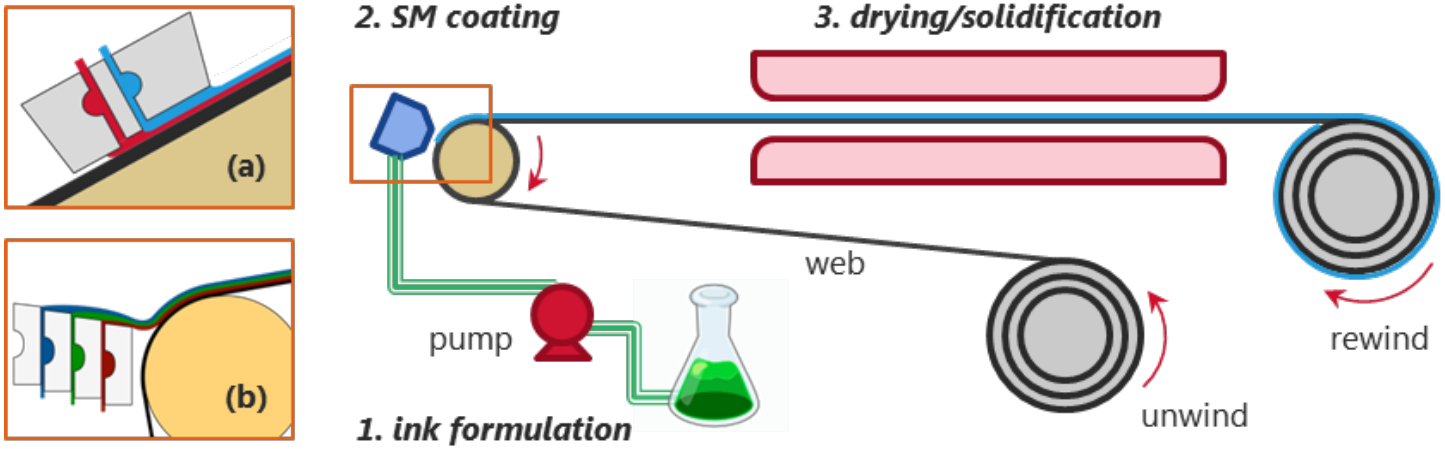


Technical Innovation

Current practice: single layer slot or tape casting (knife)



Next generation: Simultaneous multilayer coating



Technical challenges expected

Cracks

- Drying cracks
- Cracks during web handling
- Cracking during sintering

Diffusion of additives between layers

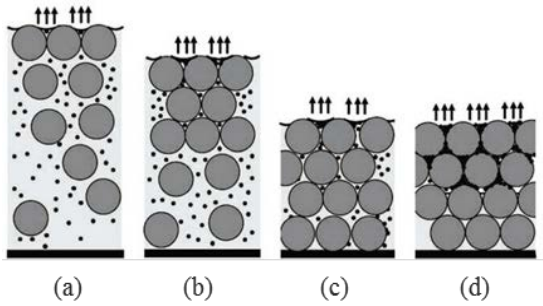
Individual layer thickness control

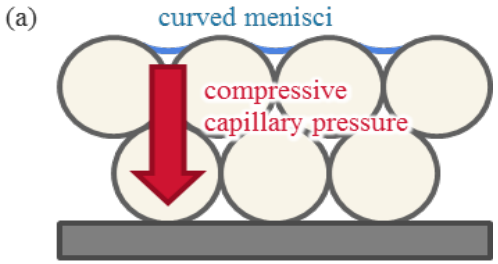
Layer intermixing

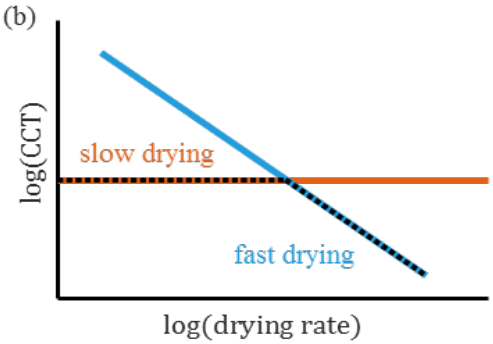
Settling of heavy particles

Bubbles & contamination

Pump pulsation







Technical Approach

Phase 1: 2 layer slot simultaneous coatings

- Ink characterization & Die design
- Use 2 layer slot coating to optimize film formation & drying
- Test each pair of the layer stack for compatibility
- Build devices from each pair to compare with tape casting
- Map out potential benefits & drawbacks (e.g. morphology, flexibility)
- Work with ORNL to build framework for techno-economic analysis
- Work with advisory board to identify new potential applications

Phase 2: 3-6 layer simultaneous coatings

- Use multilayer slide coating to cast 3-6 layers simultaneously
- Fabricate & test functional devices and compare with the benchmark
- Complete techno-economic analysis comparing various applications

Timeline & milestone table

#	Task	Lead	YEAR 1								YEAR 2							
			Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8	
	Year 1: Simultaneous slot coating of 2-layers	**SG**																
1	**Inks characterized & 2-layer SM-R2R coating**	**SG**																
1.1	Literature review			M														
1.2	Inks characterized; 1-layer slot trials, spec'ed 2-layer die			M														
1.3	Development of the first 2-layer coating					M												
1.4	Coatability assessment of remaining layer pairs																	
1.5	Production and testing of the first 2-layer coating																	
1.6	Development of 6-layer slide die specifications							M										
2	**2-layer optimization and fuel cell integration**	**SG**																
2.1	Production & testing of the remaining layer pairs									M								
2.2	Integration of the first 2-layer coating into fuel cells									M								
	Go/No-Go Decision Point (Phase 1)									G1								
	Year 2: Simultaneous slide coating of 6-layers	**SG**																
3	**6-layer coating and electrochemical testing**	**SG**																
3.1	SM 2-layer electrochemical testing of fuel cells											M						
3.2	Production and testing of 6-layer coatings													M		M		
3.3	SM 6-layer electrochemical testing of fuel cells																	M
4	**SM R2R Techno-economic analysis based**	**ORNL**																
4.1	TEA based on 2-layer coatings													M				
4.2	TEA based on 6-layers coating																	M
	End of the Project Goal																	EPG
5	**Project management and reporting**	**SG**																

Results and Accomplishments

Project has been negotiated and a start date selected

Infrastructure & resources are in place in Saint-Gobain and Oak Ridge National Lab to begin the project August 1st.

All work will be completed by July 31, 2020

Transition (beyond DOE assistance)

Commercialization by Saint-Gobain

- Markets where Saint Gobain has programs or participates

Commercialization by Saint-Gobain partners

- Markets where Saint-Gobain is a raw material provider

Other markets

- Other markets identified in techno-economic analysis
- Other markets identified by advisory board
- Commercialization & tech transfer strategy will vary

Questions?