Roll-to-Roll Manufactured Hybrid Metal-Polymer Heat Exchangers with Anti-Fouling and Self-Monitoring for Waste Heat Recovery

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University of Illinois at Urbana-Champaign
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Overview

Timeline

- UIUC Award issued April 2018
- Projected End date March 2019
- Project 10% complete

Barriers

- The barriers to waste heat recovery systems with <3yr ROI is tackled through innovations in manufacturing low–cost metal-plastic hybrid heat exchangers (next slide)

Budget

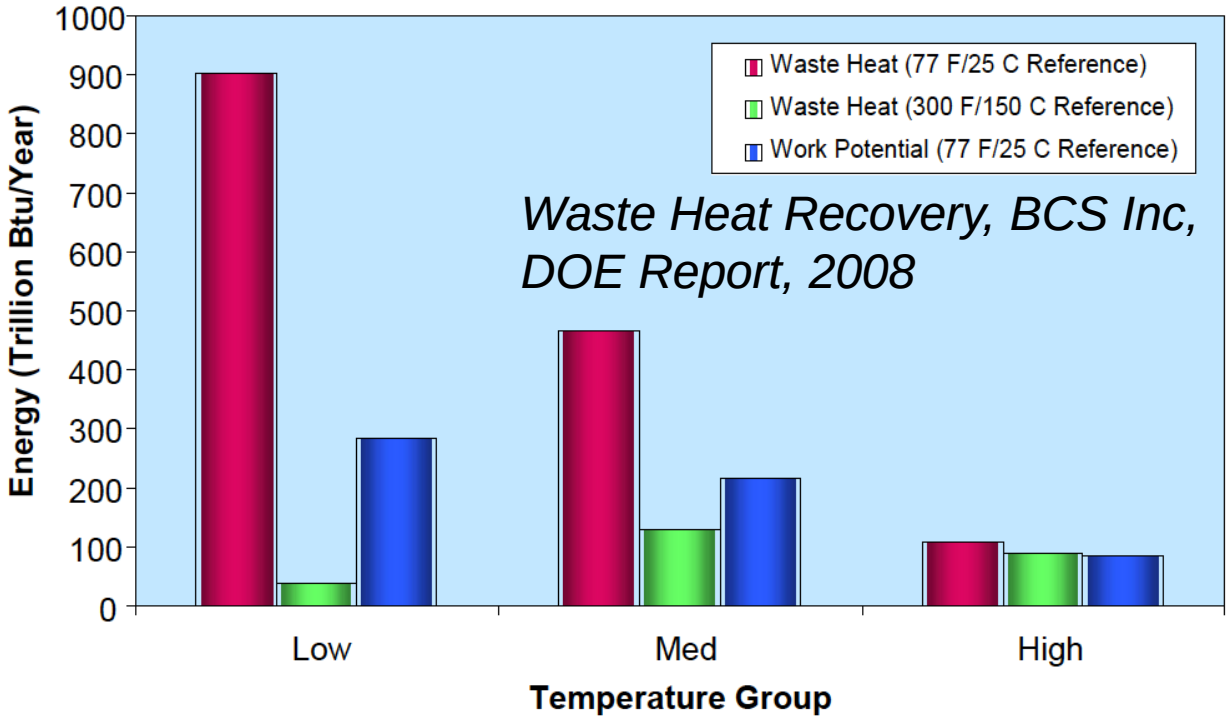
	FY 17 Costs	FY 18 Costs	Total Planned Funding (FY 19-Project End Date)
DOE Funded	$0.53 M	$0.47 M	$1.0 M
Project Cost Share	$0.13 M	$0.12 M	$0.25 M

Partners

- Modine Manufacturing in an advisory role
- Modine, based in Racine, WI specializes in thermal management systems and heat exchangers with ~$1.5 B annual revenue

Objectives

- Low temperature (< 230 C) exhaust gas streams constitute ~60% of the unrecovered industrial waste heat; No viable heat exchanger technology for low-grade waste heat recovery that meets the payback of <3 years

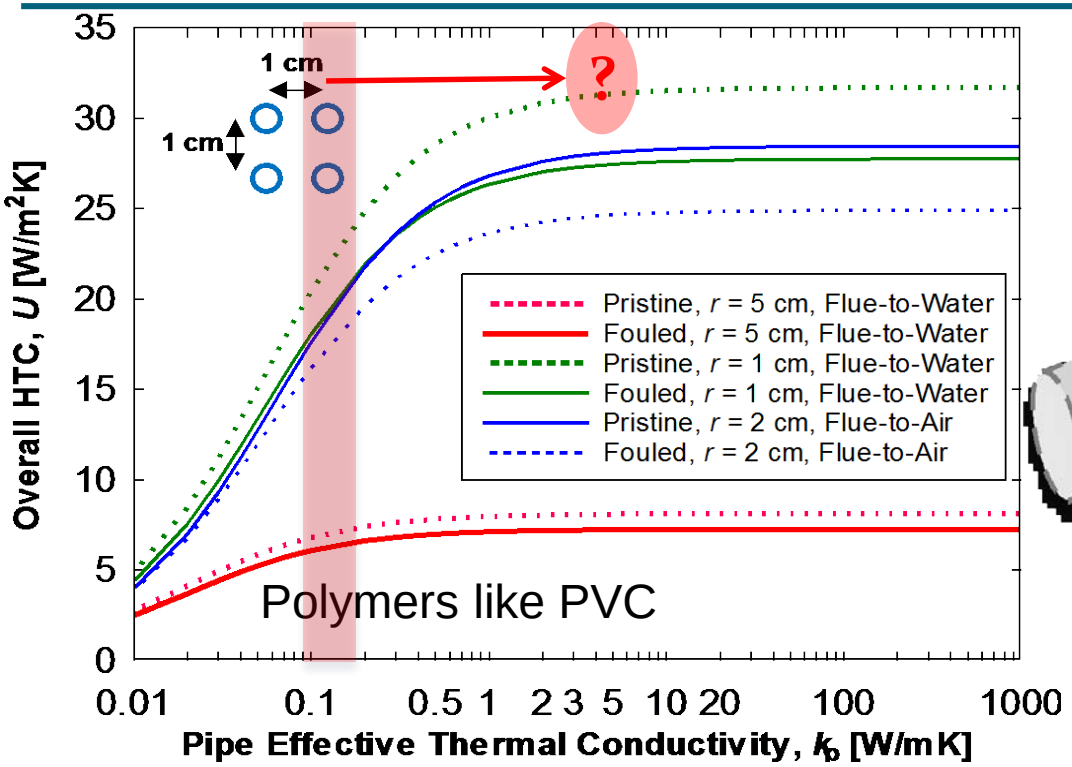


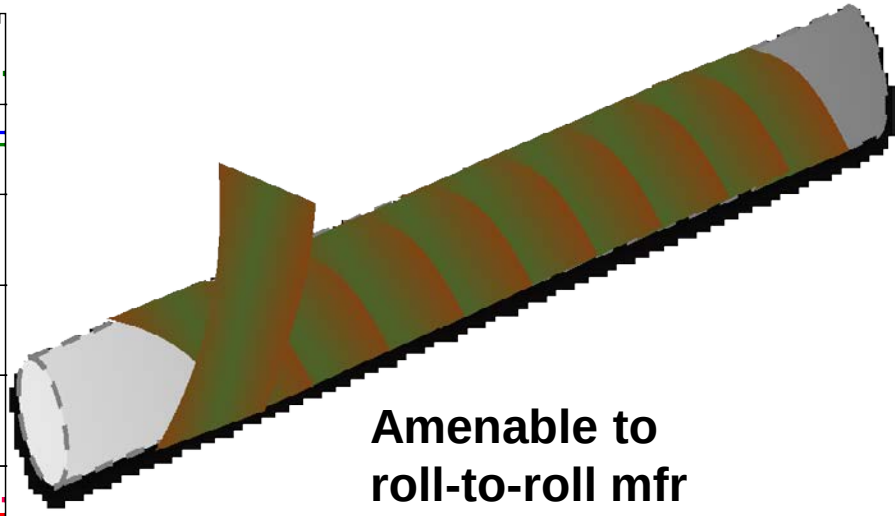
- Goal is to resolve these long standing challenges through **four distinctive innovations** in heat exchanger materials, manufacturing, anti-corrosion design and operation

Technical Innovation

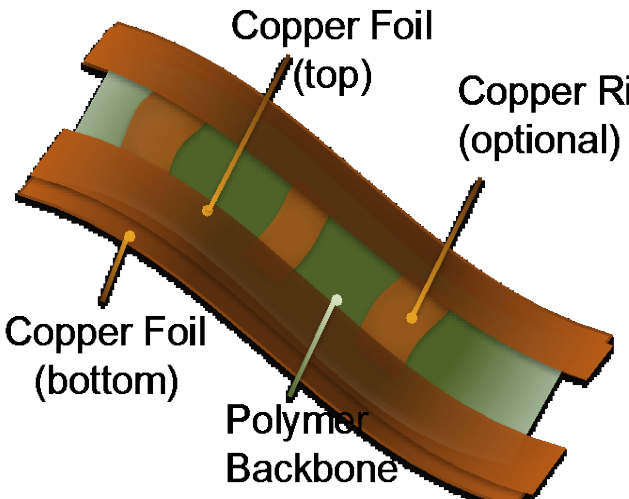
- Reduce cost of heat exchanger through materials, manufacturing and operations
- **Materials** – metal-polymer hybrid (*not* random composite) with similar overall performance as all-metal
  - *Just enough metal* to obtain optimal thermal conductivity (next slide)
  - *Avoid metal-polymer thermal interfaces* with low conductance
  - Consider *thermomechanical* performance from the outset
- **Manufacturing** – roll-to-roll process using foils and tapes with ultrasonic welding
- **Operations** – **engineered anti-corrosion**, anti-fouling coatings; operate using **combination of machine learning/controls**

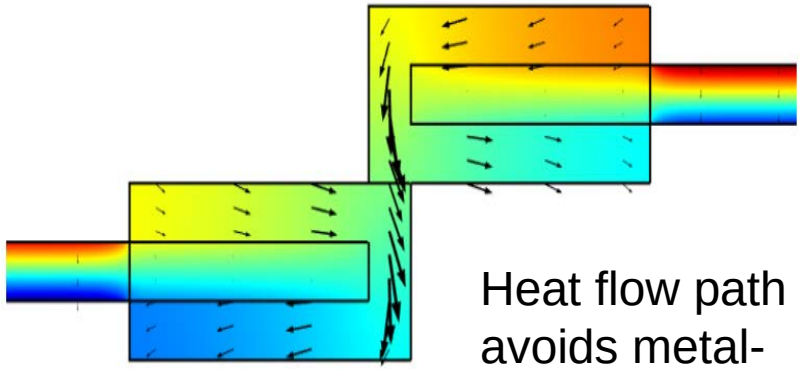
Technical Innovation – Key Idea





Amenable to roll-to-roll mfr

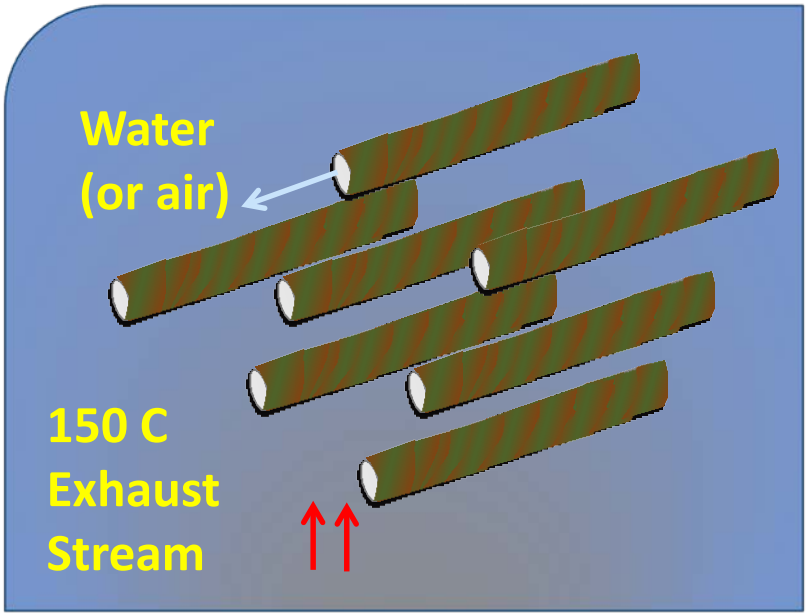


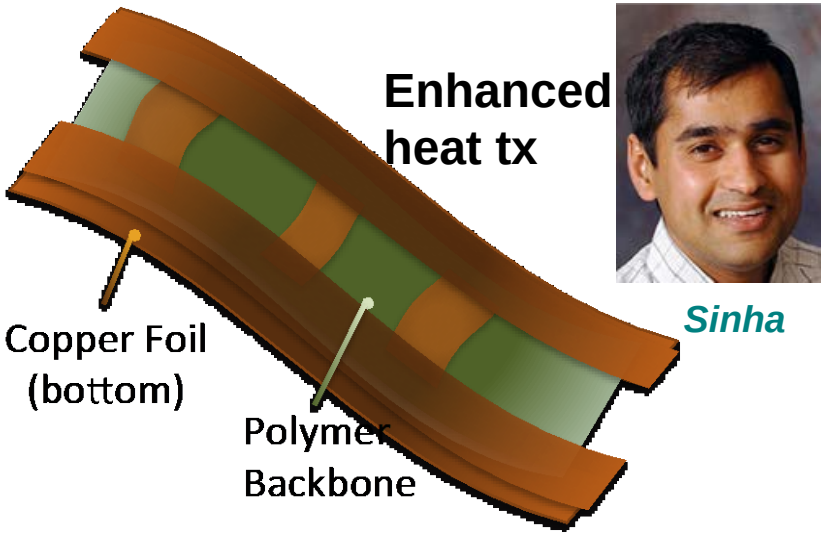


***Both** k* and *U* enhancement

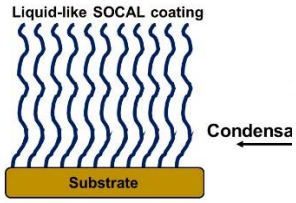
Heat flow path avoids metal-polymer interface

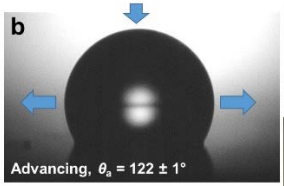
Technical Approach - Overview





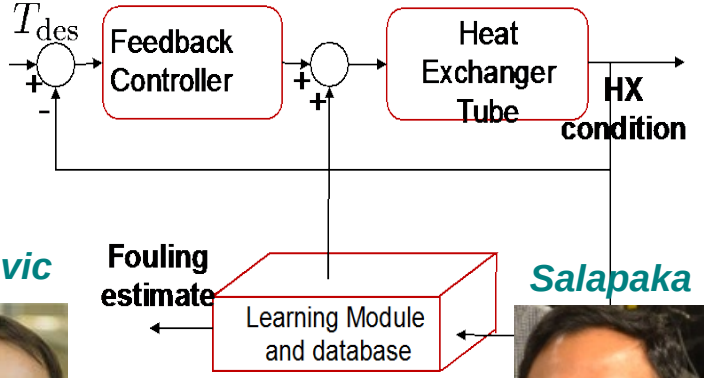
Sinha





Omniphobic coatings

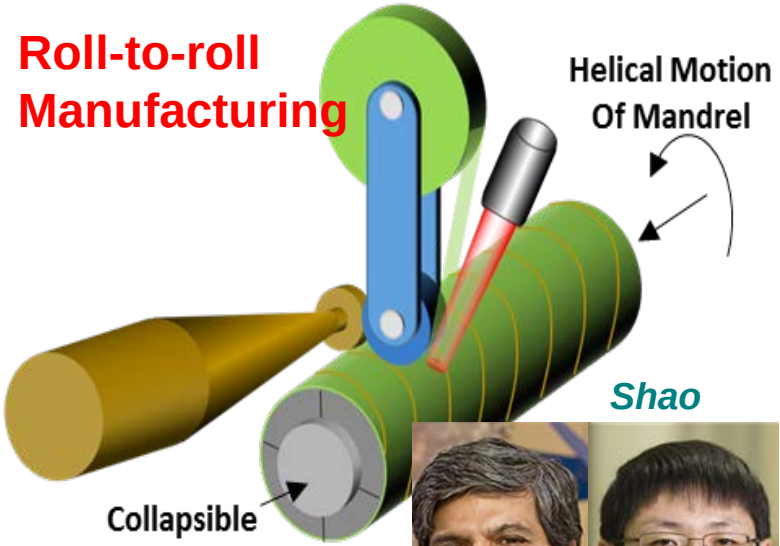
Miljkovic



Machine Learning + Controls

Salapaka

Roll-to-roll Manufacturing

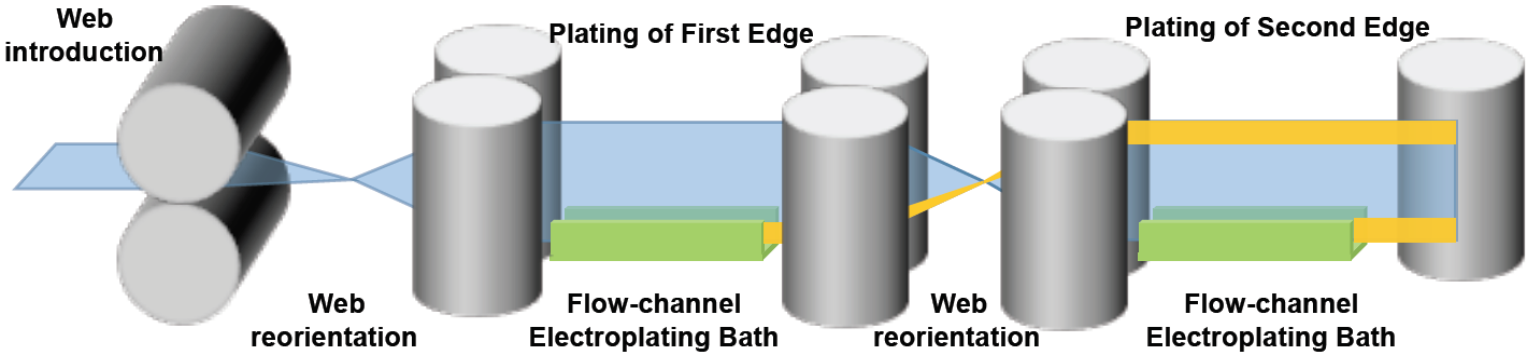


Shao

Ferreira

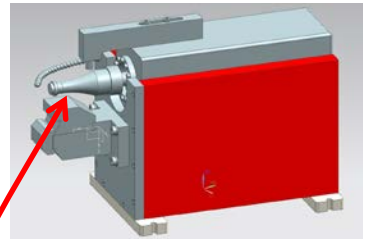
Technical Approach - Manufacturing

Avoid extra processes such as metal fin brazing
Roll to roll (R2R) entirely

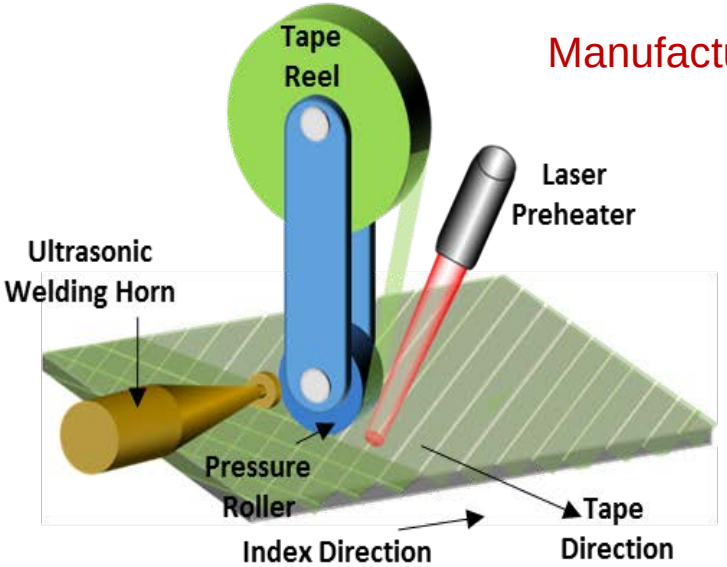


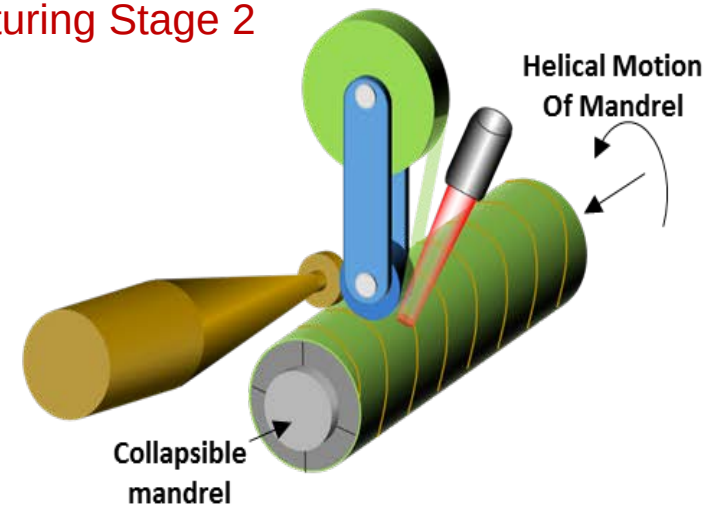
Manufacturing Stage 1

Production of polymer-copper tapes



Manufacturing Stage 2





Results and Accomplishments

Phase 1, Year 1 (~ $528 k)

- *Design, fabricate and characterize strip*
- Design heat exchanger (HX)
- Design control system
- Design anti-corrosion measures
- Design Manufacturing process

Key Deliverable

- o Characterized material strip with target properties
- o Fabricated material test sheet 4”x4”
- o Designs for HX and coatings

Phase 2, Year 2 (~ $471k)

- R2R fabrication of HX tubes
- Simulated WHR and HX testing
- Performance and Cost Evaluation

Key Deliverable

- o Demonstrate heat recovery under simulated conditions
- o Comparative performance vs market hybrid polymer material

Questions?