U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
SOLAR ENERGY TECHNOLOGIES OFFICE

SUNVAPOR RENEWABLE PROCESS HEAT

NREL NATIONAL RENEWABLE ENERGY LABORATORY

SETO CSP Program Summit 2019

Solar Steam on Demand

Low-cost zero emissions industrial heat

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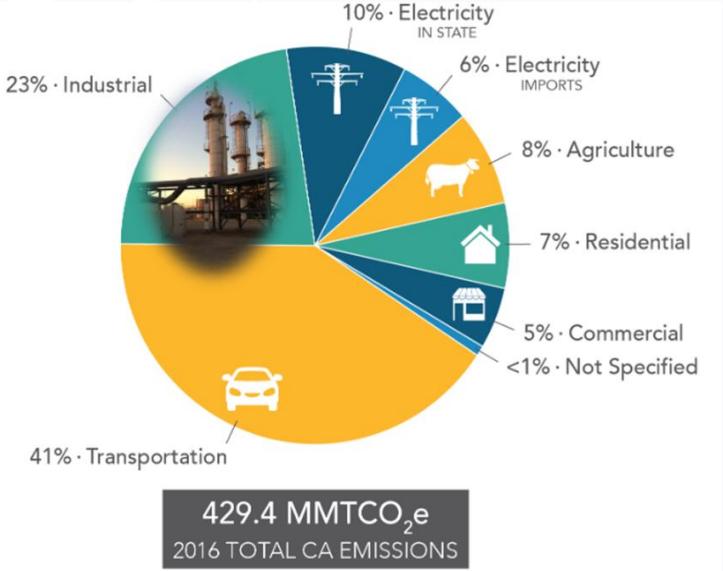
Key Outcomes and Impact

The industrial sector is the second largest emitter of greenhouse gases. Solar steam offers a viable path to lowering these emissions

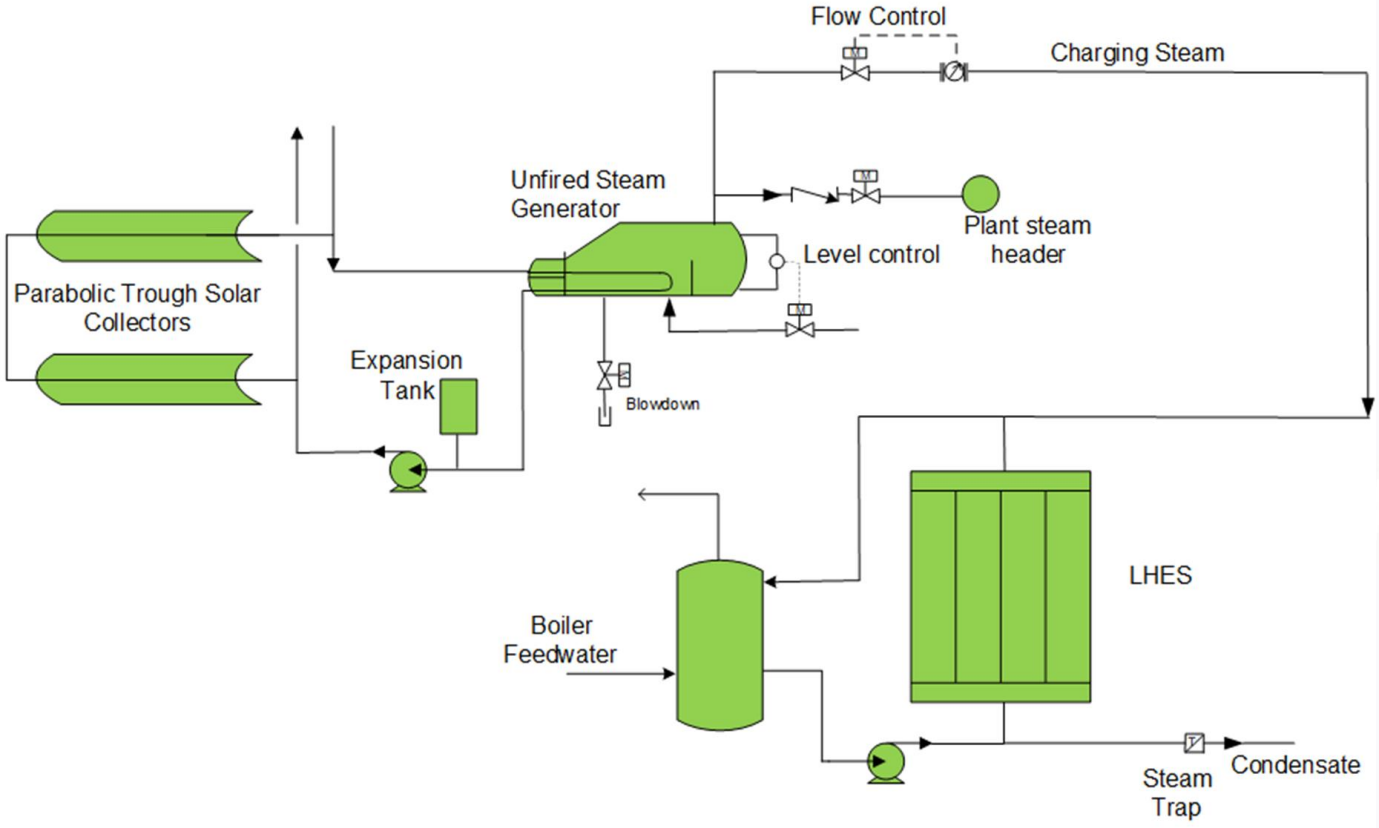
Demonstrate the potential for achieving a low Levelized Cost of Heat through steam delivered to an industrial process

Develop a storage solution that enables a significant solar fraction of generated steam

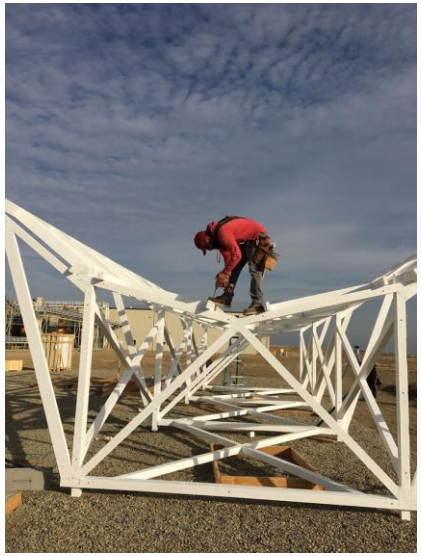


Source:
https://www.arb.ca.gov/cc/inventory/data/data.htm

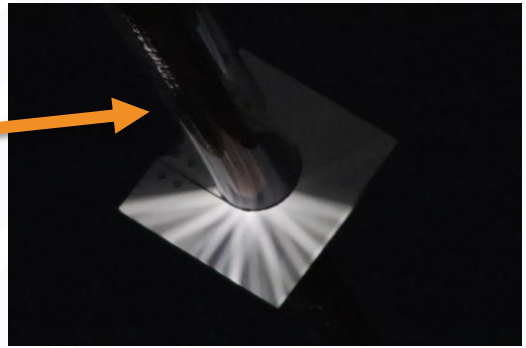
Approach: Low-cost trough collectors and latent heat energy storage

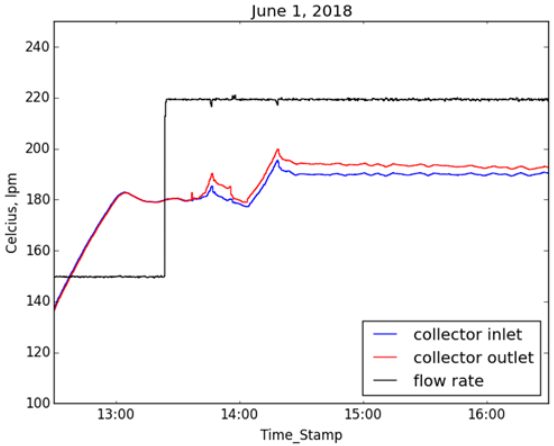


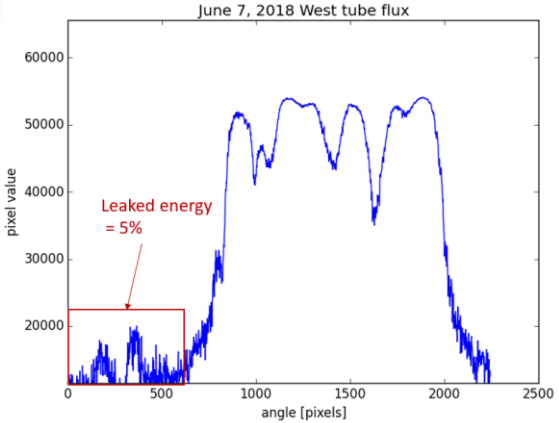
Green Parabolic Trough Collector (GPTC™)



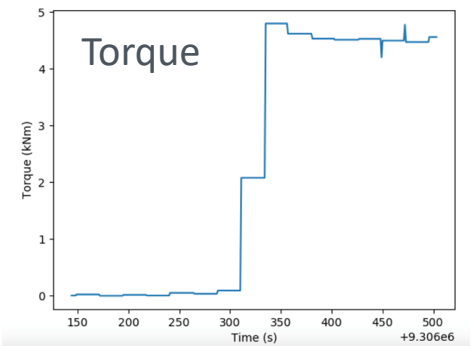
GPTC™ Module Performance Testing

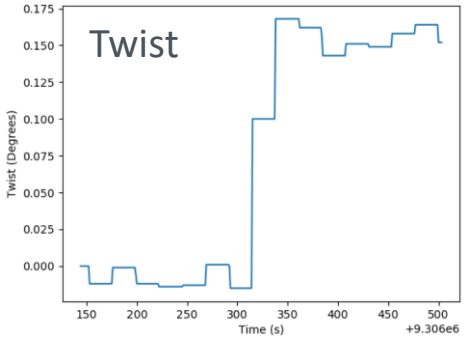




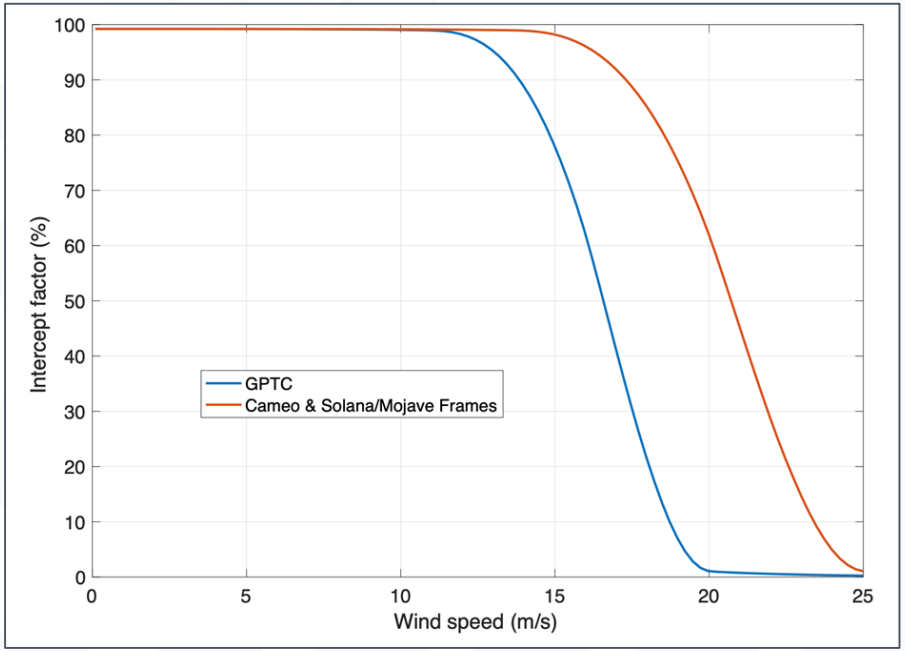


GPTC™ Torsional stiffness



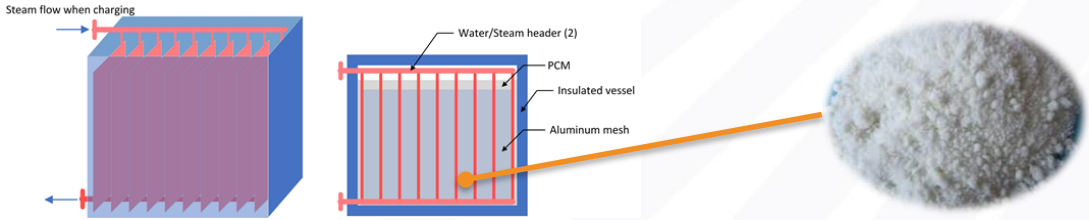


Stiffness



Latent Heat Energy Storage

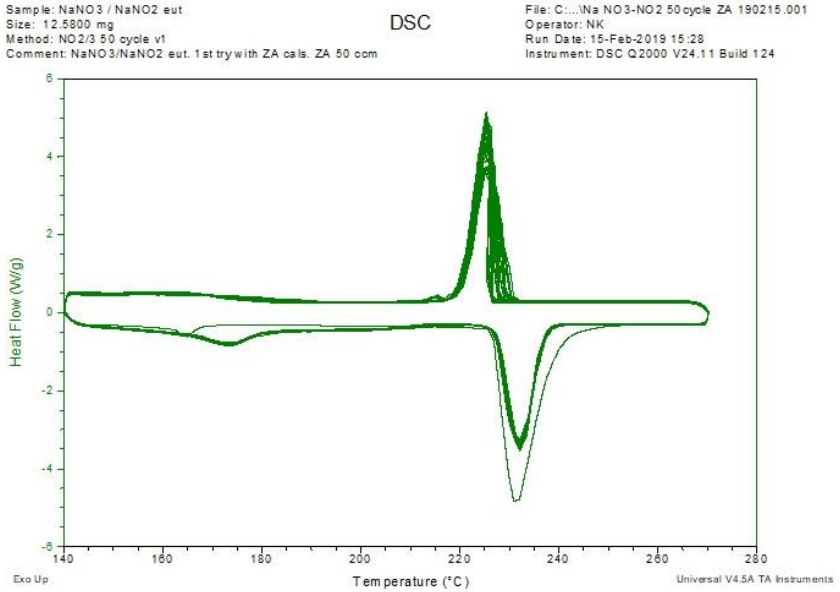
Cost of oil at \$4/kg for ΔT_{SF} ~ 40°C = \$150/kWh



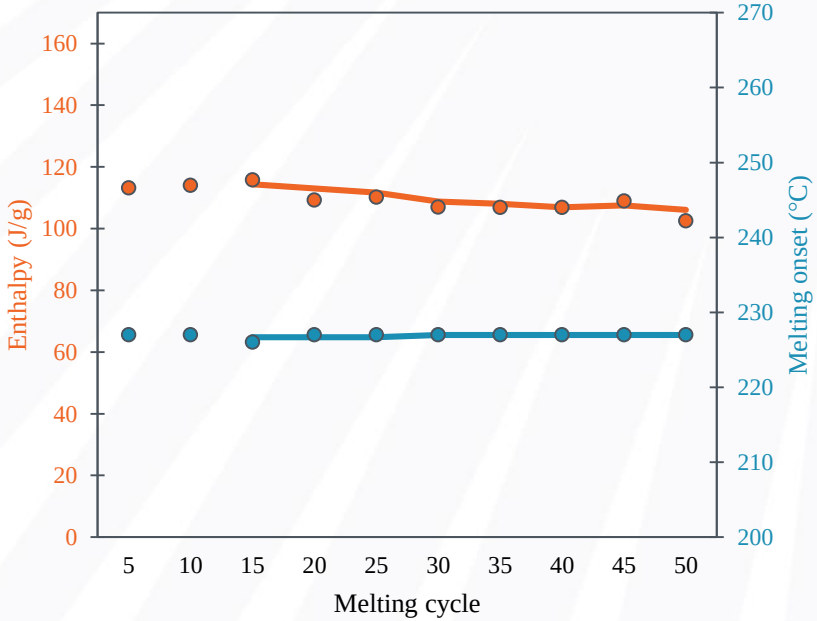
	Formates			
	KCOOH	**NaCOOH**	**Na/K COOH**	**NaNO3-NaNO2**
\$/kg	\$1.20	\$0.40	\$0.85	\$0.64
\$/kWh	\$26	\$6	\$15	\$13
MP (°C)	168	258	167	233
To (°C)	236	326	235	301

Cyclic behavior of $NaNO_3$ / $NaNO_2$

DSC

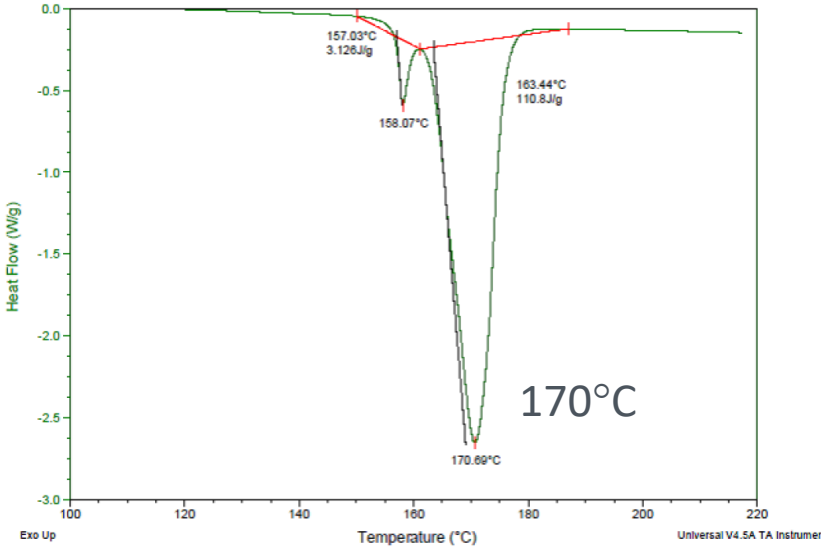


Results

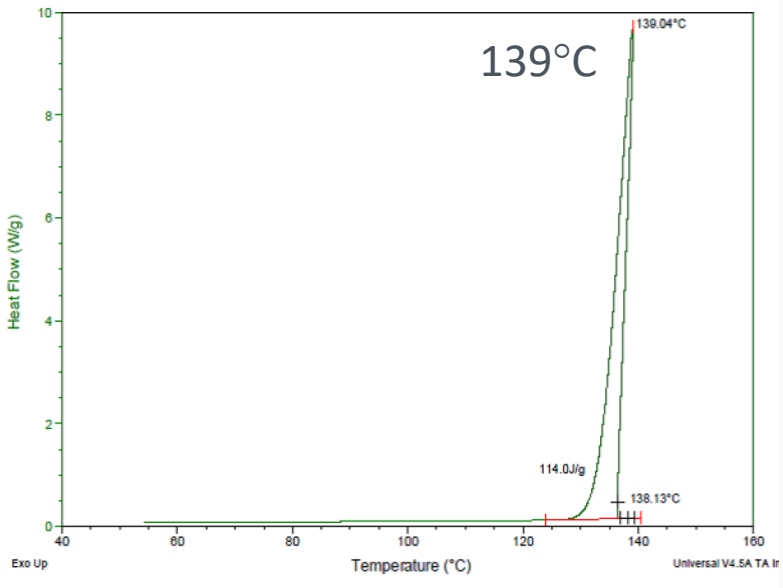


Subcooling of Formate (KCOOH)

Melting



Freezing



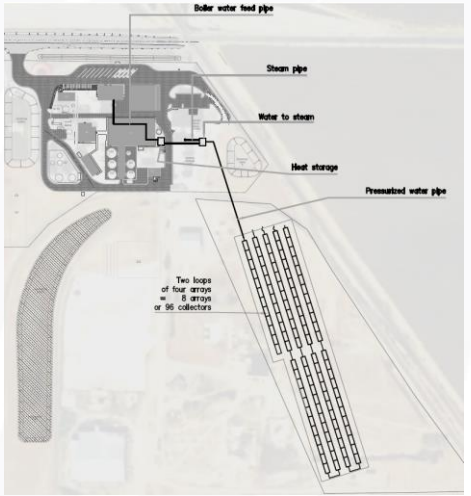
With permission: A. Koegel, "Phase change thermal energy carriers for solar industrial process heat supply", DOE Office of Science Undergraduate Laboratory Internship (SULI) Program Report

Activities Summary

Increase the technology maturity level of the GPTC™ and scale it to a full array

Test the PCM's physical and chemical properties for suitability as a storage medium. Model the heat tranfer of the storage module.

Construct and operate a solar steam generating facility that provides steam directly, and from storage, to an industrial process



Acknowledgments

Nicolas Peralta, Sue Gleckman, Ken May

Craig Turchi, Judy Netter, Noah Klammer, Prashant Sharan

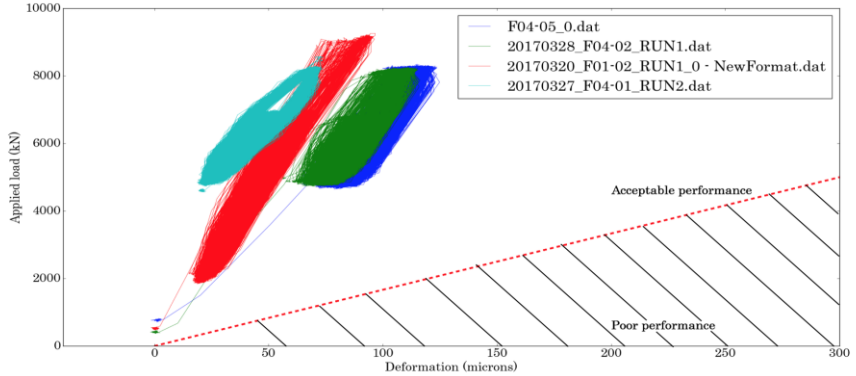
Backup slides

Aging through cyclic fatigue

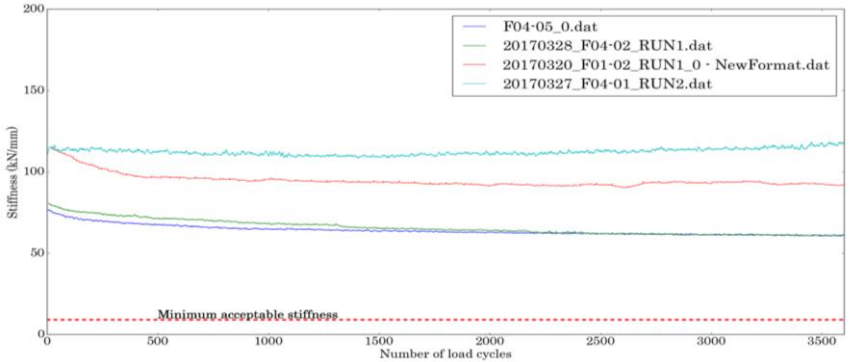
- Truss joints

Truss joint setup

- Adequate stiffness



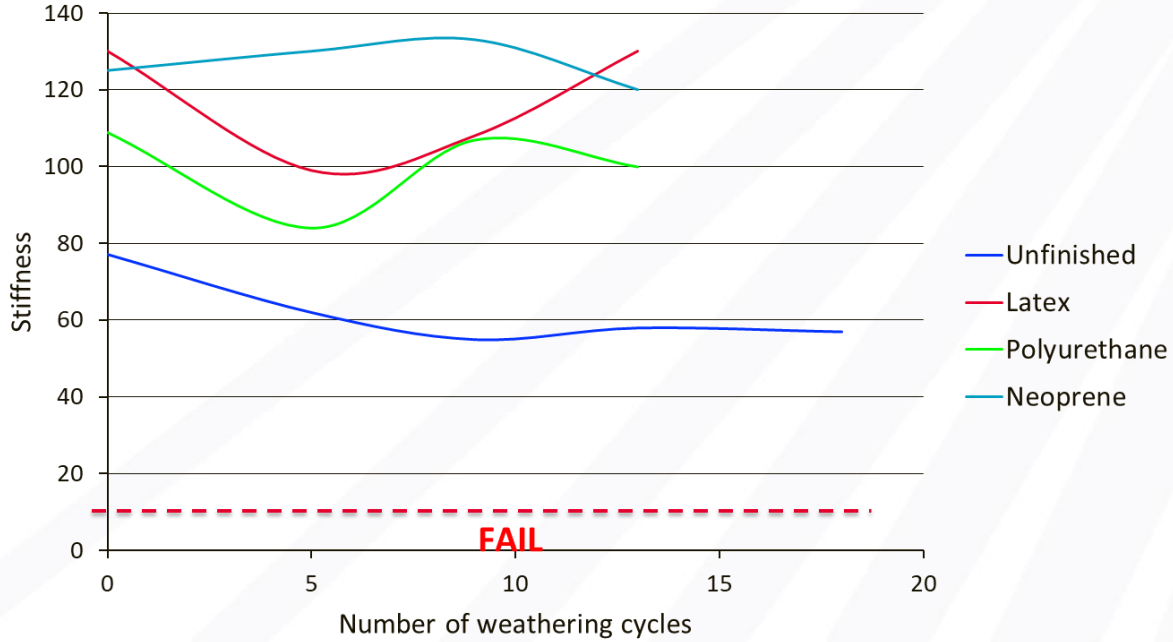
Force vs Displacement relation



Evolution of stiffness

Aging through accelerate weathering

- Accelerated weathering



Thermal stability of phase change materials