Project report 2020

REFRESH

REFRigEration based on Solid-state cooling: Heat transfer mechanisms

MAIN PARTICIPANTS

				
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OVERVIEW *(keep within this page)*

Starting year: 2019 **Current researchers** (permanent/non-permanent): 3 person-month/year

Positioning *(Multiple selection allowed – total 100%)*	**Transportation**	**Energy**	**Eng. for Health**
Materials and structure design		50%	
Surfaces and interfaces			
Simulation and modeling		50%	

Other:

Include partner from ☐ Outside ELyT ☐ Industry

Main funding source(s)
☒ Public project(s) ☐ Industrial ☒ Own resources

IFS CRP/LyC project? ☐ Yes ☒ No

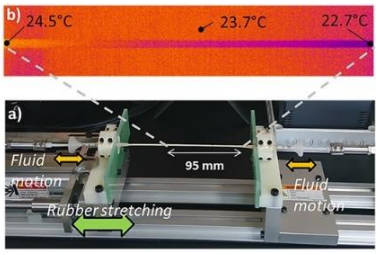
For main projects: Agency / year / name of project *(up to 3, past projects in gray)*
- ANR ECPOR (ANR-17-CE05-0016) 2017-2022
- JSPS Grant in Aid for Scientific Research Kiban C 19K04230

Estimated annual budget: 20k€

Highlights & Outstanding achievements *(3-5 bullet points)*

- We have developed a proof of concept of refrigeration based on elastocaloric natural rubber
- A model with analytical solutions was developed
- A publication was accepted in a special issue of the Journal of Applied Physics, and received distinction of "Editor's Pick", and was the subject of a "SciLight" (scientific highlight) by the American Institute of Physics.

Illustration *(5x5 cm² max)*



PROJECT DESCRIPTION

Background (10 lines max; Calibri 11)

In the framework of alternative refrigeration technologies, caloric materials exhibit entropy variations as the result of the application of an external quantity that could be an electric /magnetic field or a mechanical stress. Among them we study here the potential of natural rubber and the feasibility of its integration into preliminary proof of concept.

When driven cyclically, such a material exhibits time oscillations of temperature, and the conversion of it into a spatial gradient requires a system. Regenerative systems are among the most promising solutions. It consists of moving a fluid cyclically along the caloric material, synchronously to its temperature variations. The heat transfer mechanisms and the optimization routes remain open questions.

Key scientific question (2 lines max; Calibri 11)

How to convert time variations of temperature into spatial gradients in a regenerative system? What are the key properties of the caloric materials?

Research method (8 lines max; Calibri 11)

Within REFRESH project, we develop experimental proof of concept, along with adequate modeling. Although Computational Fluid Dynamics may bring accurate simulation for complex geometries, but costly in terms of calculations and time, it is preferred from the beginning to start from simplified approach and keep analytical solutions as much as possible, in an attempt to elucidate refrigeration mechanisms. It highlights also the key properties of caloric materials.

On the other hand the development of experimental proof of concept helps (i) verifying the model assumptions, (ii) proving the refrigeration capability of the system.

Research students involved *(gray color for previous years)*

Ph.D. candidates (years, institution):

Master/Bachelor students (years):

- Alban Duval (2020, INSA Lyon)
- Way Szu Xuen (2020-2023, Tohoku University)

Visits and stays *(gray color for previous years)*

FR to JP (date, duration):

-

JP to FR (date, duration):

-

COMMUNICATIONS AND VALORIZATION

Journal publications *(gray color for previous years)*

	Authors	Title	Journal	Vol.	pp. / ID	Year	DOI
1	G. Sebald, A. Komiya, J. Jay, G. Coativy, L. Lebrun	Regenerative cooling using elastocaloric rubber: analytical model and experiments	Journal of Applied Physics	127	094903	2020	doi: 10.1063/1.5132361

Conferences *(gray color for previous years)*

	Authors	Title	Conference	Date	City	Country	DOI *(if applicable)*
1	G. Sebald*, A. Komiya, J-M. Chenal, L. Chazeau, F. Dalmas, M. Vigouroux, F. Rousset, M. Boutaous, J. Jay, B. Garnier, M. Rammal, A. O. El Moctar, H. Haissoune, G. Coativy, L. Seveyrat, K. Yuse, L. Lebrun	Main key points for developing environmental friendly solid state cooling system based on the elastocaloric effect in rubber	2020 European Materials Research Society (E-MRS) Fall Meeting	September 16th – 19th, 2019	Warsaw	Poland	

Patents *(gray color for previous years)*

	Inventors	Title	PCT #	Year

Others *(gray color for previous years)*

	People	Event	Description	Date