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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

Tuesday, 22 April 2025, 9:00 s.t., via Zoom



Assist. Prof. Dr. Jaka Tušek
Laboratory for Non-Linear Mechanics LANEM,
University of Ljubljana

Elastocaloric cooling and heating: From the elastocaloric effect towards an efficient and fatigue-resistant device

Abstract:

Elastocaloric cooling and heat-pumping is emerging as one of the most promising environmentally friendly alternatives to vapor compression technology. It is based on the elastocaloric effect that occurs during the superelastic cycling of shape memory alloys. In this talk I will discuss the development and the performance of a fatigue-resistant regenerative elastocaloric device. This was achieved through the systematic characterization of the elastocaloric effect of Ni-Ti based shape memory alloys, their fatigue behavior, their buckling stability under compressive loading and the thermohydraulic characterization of different regenerator geometries. Although the developed tube-based elastocaloric regenerator shows promising results with maximum temperature span of more than 30 K and specific cooling/heating power of above 4.5 W per gram of elastocaloric material, further improvements, particularly by decreasing the hysteresis losses of elastocaloric materials and improving specific heat transfer surface of elastocaloric regenerators, are required to increase the efficiency of elastocaloric devices. Finally, an innovative cam disk-based driving system of the elastocaloric heat pump, which enables efficient work recovery, will be discussed.

About the speaker:

Dr. Jaka Tušek an Assistant Professor at the Faculty of Mechanical Engineering, University of Ljubljana (Slovenia) in the field of thermal and process engineering. His PhD thesis (at the University of Ljubljana) was on designing active magnetic regenerators to be applied in a magnetic refrigeration system. After the PhD he spent two years as a Postdoc at the Technical University of Denmark working on elastocalorics. His research interest includes cooling and heat-pumping based on caloric effects in ferroic materials. He published more than 50 scientific papers in international scientific journals, among others in Nature Energy, Science, Joule, Advanced Energy Materials, Applied Materials Today, Energy Conversion and Management and Acta Materialia. He is a co-author of a scientific book and has two international granted patents. In 2018, he received currently the most prestigious European research grant founded by European Research (ERC Starting grant) in the amount of 1.4 million euros for research in elastocaloric cooling technology. To date, he has acquired and lead projects in the total amount of about 3.5 million euros (ERC Starting grant, ERC Proof of the concept grant, EIC Pathfinder grants, national and industrial projects).

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Spokesperson: Prof. Dr. Oliver Gutfleisch • Co-Spokesperson: Prof. Dr. Michael Farle
Management: Dr. Sonja Laubach • L2|07 107 • sonja.laubach@tu-darmstadt.de • +49 (0)6151 16-22153
Address: CRC/TRR 270 • TU Darmstadt • Peter-Grünberg-Str. 16 • 64287 Darmstadt