LITHUANIAN ENERGY INSTITUTE

ADMISSION TO PHD STUDIES FOR THE YEAR 2025

DOCTORAL RESEARCH TOPIC:

Analysis and control of hydrodynamic flow structures for microfluidic device applications

RESEARCH FIELD:

Energetics and Power Engineering (T 006)

BRIEF DESCRIPTION OF RESEARCH TOPIC:

Microfluidic systems are innovative devices that enable manipulation of extremely small quantities of fluids or particles through systems of channels and flow control components on a micro- or nanoscale. Microfluidic devices such as lab-on-a-chip, organ-on-a-chip, droplet microfluidics, particle sorting and continuous flow microfluidic devices ant their applications are rapidly expanding interdisciplinary research field encompassing physics, biochemistry, and microsystems engineering. Research on microfluidic devices contributes to innovation across multiple fields, reducing costs, accelerating processes, and creating new opportunities to develop small-volume, high-precision devices applicable in medicine, chemistry, environmental science, and other areas.

A primary challenge in designing microfluidic systems lies in the precise selection of parameters to achieve targeted flow effects. Given the adaptability of these systems to a wide range of applications, a deep understanding of the fundamental principles governing flow structure, control techniques, and dependencies on channel geometries and fluid properties is essential. This includes analysing how flow structures and channel geometries impact particle movement within the flow, as well as the interactions in two-phase fluid systems. In view of the challenges to be addressed and the intended research objectives, this doctoral research topic aligns with the Lithuanian Energy Institute's strategic focus on "thermal physics, fluid dynamics, and metrology research."

This topic covers two main aspects: investigation of hydrodynamic flow structure, referring to understanding the patterns and behaviors of fluid flow within microfluidic environments, such as flow patterns, vortices, or recirculation zones, which are crucial for manipulating particles or biological cells in these devices. And control of flow and application in microfluidic devices, emphasizing methods for actively or passively controlling flow structures, which is critical for applications like particle sorting, drug delivery, or biochemical reactions in lab-on-a-chip devices.

The proposed research aims to employ experimental and numerical methods to deepen understanding of flow dynamics principles and assess the influence of governing parameters. This knowledge will be applied to address challenges in flow control, hydrodynamic particle manipulation, heat transfer enhancement, pressure loss reduction, and related areas.

In pursuing this research topic, one may **choose from the following proposed dissertation themes:**

- Experimental and numerical investigation of flow structure and dynamics in components of microfluidic applications.
- The analysis of microparticles behaviour in complex structures.
- Investigation of hydrodynamic particle control in microfluidic applications.
- The analysis of parameters governing droplet generation and control in droplet-based microfluidics devices.

SCIENTIFIC SUPERVISOR:

Dr. Paulius Vilkinis
Laboratory of Heat-Equipment Research and Testing

Lithuanian Energy Institute
Breslaujos 3, 44403 Kaunas
Lithuania

Paulius.Vilkinis@lei.lt

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