

WROCLAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ELECTRONICS, PHOTONICS AND MICROSYSTEMS

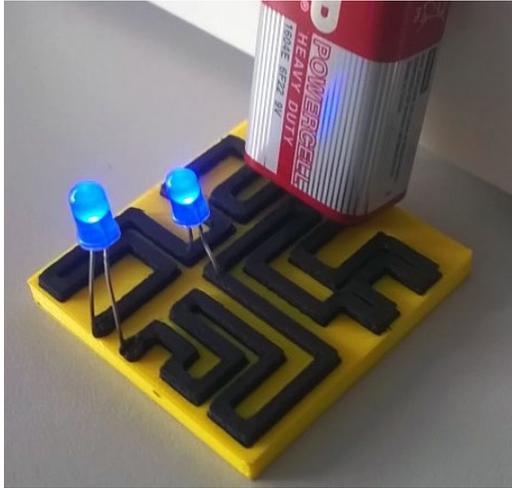
3D printing task

Topic: **„ Design and Characterization of 3D-Printed Resistive and Capacitive Elements Using Conductive Filaments “**

Description and goals:

Conductive filaments used in fused deposition modeling (FDM) 3D printing enable the fabrication of electrically functional structures directly within additively manufactured parts. Unlike conventional metallic conductors, conductive filaments exhibit bulk percolation-based conductivity, resulting in relatively high resistivity, anisotropic electrical properties, and strong dependence on geometry, print parameters, and environmental conditions. As a result, such materials are not suitable for power transmission or high-speed signal routing, but they are highly relevant for printed sensors, human-machine interfaces, and experimental electromechanical structures.

This laboratory module focuses on the design, fabrication, and characterization of printed resistive and capacitive elements using conductive filaments, with particular emphasis on understanding the relationship between geometry, print parameters, and electrical performance. The students will experimentally investigate printed resistors of varying length, width, and thickness, as well as capacitive touch electrodes fabricated using conductive polymer filaments embedded within insulating printed substrates. These investigations highlight the limitations of conductive filaments while simultaneously identifying application domains where their unique properties are advantageous, such as low-cost sensors and interactive surfaces. The overarching goal of the project is to develop engineering intuition regarding additively manufactured conductive materials rather than to replicate conventional printed circuit board (PCB) technologies.



The following sub tasks will be due:

- Literature and datasheet review of conductive filament materials and percolation-based conductivity mechanisms
- Laboratory characterization of bulk resistivity in printed conductive filaments
- Experimental investigation of resistance as a function of printed geometry (length, width, thickness, and layer orientation)
- Fabrication and testing of printed resistive elements
- Design and laboratory evaluation of printed capacitive and resistive touch sensors
- Investigation of environmental effects (temperature, mechanical deformation) on electrical performance
- Documentation and critical analysis of experimental results, including discussion of limitations and suitable application domains

Responsible

Professor: Prof. Sergiusz Patela

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