Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences (TIB PAN)

SUBJECT: Reversibly deformable micro- and nanostructured materials for biomedical applications

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DESCRIPTION:

Wearable biomaterials are transforming medical treatments by making them less invasive and more effective [1]. However, traditional polymeric biomaterials often lack sufficient stretchability, and bendability, which limits their practical application. To ensure optimal performance, biomaterials must adhere seamlessly to the target surface. Therefore, in addition to being biocompatible, they should mimic the mechanical properties of the tissue to enable effective integration. This requires the material to accommodate surface deformations caused by continuous body movement. Mechanically flexible polymeric biomaterials with engineered reversible deformability have demonstrated enhanced adhesion to the treatment site [2].

Hydrogels and electrospun nanofibrous biomaterials naturally offer flexibility and moderate stretchability. Nevertheless, their elongation capacity is often insufficient to fully adapt to the dynamic morphology of the human body, and their ability to recover their original shape remains limited, making them suboptimal as foundational materials. Thus, additional post-fabrication modifications are necessary to meet performance requirements.

The proposed PhD project aims to design and develop advanced materials composed of hydrogels and biopolymers using electrospinning and laser structuring techniques. The resulting micro- and nanostructures will be thoroughly characterized to demonstrate their enhanced properties and exceptional functionalities. The study will also investigate the potential of these nanomaterials in various biomedical applications, such as drug delivery and tissue engineering. This research is expected to lead to multiple publications in high-impact international journals and presentations at prominent scientific conferences.

REQUIREMENTS:

- Holding an MSc degree in Chemistry, Polymer Science, Physics, Nanotechnology, or any related field of Materials Engineering
- Solid background in polymer material development (expertise in electrospinning as well as hydrogel and/or conductive polymer nanomaterial fabrication is desirable)
- Keen interest in polymer nanomaterial characterization (e.g., SEM, AFM, FT-IR, XRD, DSC, TGA, Photothermal characterization, etc.)
- Ability to design, execute, and evaluate research experiments
- Excellent collaboration skills as well as the ability to work independently
- Highly capable of communicating scientific results in English, both orally and in writing

BIBLIOGRAPHY:

[1] Hong S. et al., Biomaterials for reliable wearable health monitoring: Applications in skin and eye integration, Biomaterials, pp.122862, 2025.
[2] Nakielski P. et al., Ultra-Stretchable and Environmentally Resilient Hydrogels Via Sugaring-Out Strategy for Soft Robotics Sensing , Advanced Functional Materials, pp. 2315184, 2024.