

# Doctoral School of Information and Biomedical Technologies

## Polish Academy of Sciences (TIB PAN)

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**SUBJECT:** Photoresponsive 3D Platforms Based on Natural Biowaste for Antibacterial Applications

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**DESCRIPTION:** Photoresponsive biomaterials derived from natural biowaste represent a new generation of sustainable, innovative materials for biomedical applications [1]. These materials offer environmental benefits and exhibit unique functionalities, such as light-triggered heat generation. When exposed to near-infrared (NIR) light, biowaste-derived compounds like natural melanin can convert light into localized heat, enabling non-invasive, targeted therapies [2]. This approach aligns with current trends in personalized medicine and eco-friendly material development.

The proposed PhD project aims to design and fabricate a 3D photoresponsive platform that integrates melanin obtained from natural biowaste and thermosensitive polymer carriers loaded with non-steroidal anti-inflammatory drugs (NSAIDs). Upon NIR irradiation, the platform will generate controlled heat for dual action: bacterial eradication and on-demand drug release. This system offers a promising antibiotic-free therapeutic strategy for bacterial infections and inflammatory conditions.

The resulting systems will undergo extensive studies to demonstrate their unique features and exceptional functionalities, including precise thermal activation and antimicrobial effectiveness. The project combines elements of materials science, nanomedicine, and sustainable biotechnology. Results are expected to contribute to innovative smart therapies and will be disseminated through publications and conference presentations.

### REQUIREMENTS

- Possession of an MSc degree in Chemistry, Polymer Science, Physics, Nanotechnology, Materials Engineering, or a closely related discipline.
- Strong foundation in the development of polymer-based materials; experience with 3D printing techniques and the synthesis of hydrogels or thermoresponsive polymer nanomaterials will be considered an advantage.
- Genuine interest in the characterization of polymer nanomaterials using techniques such as SEM, DSC, TGA, FT-IR, XRD, in vitro cell and bacteria study, and photothermal analysis.
- Proven ability to independently plan, conduct, and analyze scientific experiments.

- Excellent teamwork skills combined with the capacity to work autonomously.
- Proficiency in communicating scientific findings clearly and effectively in English, both in spoken and written forms.

## **BIBLIOGRAPHY:**

[1] D. Rybak et al., NIR-Light Activable 3D Printed Platform Nanoarchitected with Electrospun Plasmonic Filaments for On Demand Treatment of Infected Wounds. *Adv. Healthcare Mater.* 2025, 14, 2404274. <https://doi.org/10.1002/adhm.202404274>

[2] M. Bartolewska et al. Eumelanin-Enhanced Photothermal Disinfection of Contact Lenses Using a Sustainable Marine Nanoplatfrom Engineered with Electrospun Nanofibers. *Adv. Healthcare Mater.* 2025, 14, 2402431. <https://doi.org/10.1002/adhm.202402431>