

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

SUBJECT: Piezoelectric 3D Constructs for Cartilage Regeneration

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DESCRIPTION: Piezoelectric materials are a class of smart materials capable of converting mechanical stress into electrical signals and vice versa, influencing cellular behaviors and bioelectrical environments [1]. Their unique properties, such as electrical stimulation and charge transfer, have been shown to modulate physiological processes, including stem cell differentiation, neuronal activation, and muscle regeneration. In tissue engineering, they hold great potential for osteochondral repair by promoting chondrogenesis and osteogenesis, particularly through ultrasound-activated electrical cues that mimic natural bioelectric signals essential for tissue development and healing [2,3].

An innovative piezoelectric scaffold for cartilage regeneration will be designed and developed. Osteochondral defects caused by trauma, arthritis (including osteoarthritis), cancer, and other degenerative conditions might be regenerated using specific 3D constructs. By integrating piezoelectric nanoparticles with hydrogel, cellular functions such as migration, differentiation, and extracellular matrix synthesis will be enhanced. The biomimetic scaffold will recreate the complexity of native osteochondral tissue, providing a sustainable platform for *in-vitro* drug screening and regenerative applications.

REQUIREMENTS:

- MSc degree in Materials Science and Engineering, Nanotechnology, Biomedical Engineering, Chemistry, or related fields.
- Strong background in biomaterials, particularly polymeric and piezoelectric materials.
- Experience in fabrication techniques such as 3D printing, electrospinning, or hydrogel synthesis.
- Familiarity with characterization methods (e.g., SEM, FT-IR, XRD, DSC, TGA, DMA, piezoelectric testing).
- Experience in *in-vitro* analysis will be an advantage.
- Ability to conduct independent research and collaborate in an interdisciplinary team.
- Proficiency in scientific communication and publication in English.
- Communicative Polish skills will be a plus.

BIBLIOGRAPHY:

1. Zaszczynska, A., Sajkiewicz, P., & Gradys, A. (2020). *Piezoelectric scaffolds as smart materials for neural tissue engineering*. Polymers, 12(1), 161.
2. Zaszczynska, A., Zabielski, K., Gradys, A., Kowalczyk, T., & Sajkiewicz, P. (2024). *Piezoelectric scaffolds as smart materials for bone tissue engineering*. Polymers, 16(19), 2797.
3. Urbanek, O., Kołbuk, D., & Wróbel, M. (2018). *Articular cartilage: New directions and barriers of scaffolds development – review*. International Journal of Polymeric Materials and Polymeric Biomaterials, 68(7), 396–410. <https://doi.org/10.1080/00914037.2018.1452224>