Sustainable design of hybrid (textile-materials) active conductive structures in Frequency-Selective Surface systems (FSS) with dominant incident wave absorption coefficient or reflected beam directing capabilities of Electromagnetic Radiation (PEM)

The scientific aim of the project is to achieve **hybrid (textile-composite), active conducting structures in frequency selective surfaces** (FSS) systems dominant in absorbing incident wave or beam steering capabilities of electromagnetic radiation (EMR) within a specified frequency range used to limit the intensity of electromagnetic radiation. Electromagnetic radiation currently forms the basis of operation for various electronic systems and devices communicating wirelessly or exchanging information. However, the increasing number of such devices contributes to the phenomenon known as electromagnetic smog, which can already pose problems in terms of disrupting the operation of these devices and potentially endangering human environmental functioning. The planned activities will aim to **reduce the intensity of electromagnetic radiation in terms of broadband or selective screening**.

The scientific activities planned in the project will involve research on the design of **new types of frequency selective structures** based on textile substrates and realized using textile technologies such as embroidery and weaving. Frequency selective textile screens made on substrates and **using textile techniques (embroidering and weaving)** are attractive due to a number of characteristics that distinguish them from commonly used screens based on metals and their alloys. Textile screens are characterized by low mass, high elasticity, easy shaping and processing, the possibility of constructing protective clothing, and ease of transportation and storage.

During the research, answers will be provided to the following questions and research hypotheses:

- What are the limitations of weaving methods and computerized technical embroidery in obtaining small and large frequency selective structures?
- What is the effectiveness and bandwidth of the shielding obtained from the barrier properties of hybrid FSS systems with dominant attenuation coefficients?
- What are the possibilities for directing (angle, change of direction) the reflected beam of EMR from hybrid FSS systems?
- What are the most effective technologies enabling the integration of active electronic elements with electro-conductive threads on dielectric textile substrates?
- What could be the methods of activating/switching electronic devices implemented in hybrid FSS structures to change the properties of such a structure?
- What are the possibilities and techniques for implementing spatial, hybrid FSS structures?
- How does the possibility of savings on reducing the consumption of conductive fibers in the context of sustainable development affect the deterioration of the barrier properties of FSS structures?
- What are the limitations regarding constituent materials when obtaining hybrid FSS structures?

The process of designing modern, selective, hybrid shielding materials will involve the intended change in the proportions between the reflection, absorption, and transmission coefficients of the electromagnetic wave. In the authors' assumption, **the new shielding materials will act as selectively absorbing or transmitting filters for EM radiation, while the blocking action will utilize the phenomenon of wave attenuation and its conversion into heat or directed reflection of the incident beam**.

The combination of unique properties of conducting structures with fibrous materials made from natural fibers and yarns possessing conductive properties may pave the way for the creation of completely **new solutions in the field of hybrid systems on a global scale**.