

Design, fabrication and properties of ceramic-polymer composites with high dielectric tunability

The purpose of the joint project fulfilled in scientific centers in Poland and China is to develop the innovative ferroelectric ceramic-polymer composites and to determine the nature of the interactions between powder particles and organic additives on electrical parameters of the developed composite. This will be possible thanks to the close cooperation of three scientific units: the Warsaw University of Technology, the Institute of High Pressure Physics of the Polish Academy of Sciences and the Northwestern Polytechnical University in Xi'an, China. The scope of research within the project is based on unique experience of the partners and includes the synthesis of ceramic and polymeric materials, their functionalization and the formation of composite ferroelectric tapes. The important element of this project is the development of a model of composite systems tunability based on measured changes of the material dielectric constant in external electric field. The work program within the project includes also designing and testing of developed materials by using a measurement system in a wide frequency range, up to 500 GHz.

In order to prepare dielectric composites based on barium-strontium titanate (BST) by tape casting method, the partners will focus on the influence of ceramic particles and polymers on rheological parameters of suspensions. Previous work has shown that interactions between functional groups of the polymer and the surface of ceramic powder grains have a huge impact on their dielectric parameters. These factors will be taken into account at the stage of building the theoretical model describing tunability of ferroelectric composite systems. The work program includes also composites testing in a huge range of frequencies (up to 500 GHz) in order to obtain their full electric characteristic.

The research subject is very important from the point of view of modern materials and technologies operating at very high frequencies (sub-THz). At this point, ceramic ferroelectric materials are used in aerospace, space technology and advanced communication systems. One possible application is, for example, a high frequency imaging system to ensure safety by searching for dangerous materials and tools during security screening at airports. For the described innovative composite materials, in order to be able to function fully and safely in public spaces, there is the necessity to fulfill knowledge gaps regarding possibilities of modification and control of their properties. This project, through the ambitious goal of creating a model and performance characteristics of these materials, is a milestone in the wider use of this type of materials in inter alia modern telecommunication and aerospace technologies.