Materials and Manufacturing Methods for Electromagnetic Energy Harvesting Devices

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With the exponential growth of wireless infrastructure, a new, abundant energy source has emerged as telecommunications, mobile networks, and Wi-Fi ensuring radio frequency (RF) energy in our surroundings. This allows powering sensor networks directly from the RF energy in the environment. The microwave energy harvesting device is the rectenna, which consists of an antenna, a matching network, and a rectifier that converts the microwave signal induced in the antenna into DC voltage.

Our research aimed to modify the rectennas to maximize their efficiency and pave the way for the next generation of wireless energy harvesters. This included the development of high-quality microwave dielectrics for resonators used for antennas and elaborating the metallization when forming metallic patterns on a surface of dielectric that is necessary for antenna performance.

Multiphase dielectric materials were developed based on a mixture of ilmenite, spinel, and perovskite phases, which provided low dielectric losses and high thermal stability. The electrical properties of the synthesized ceramics were investigated using a technique of a bulk metallic resonator and the method based on phase measurement from the ceramic sample inserted into the shorted coaxial line. The resonators in the shape of cylinders were manufactured.

To form metallic patterns on a dielectric, we used selective surface activation induced by a laser (SSAIL) method [1]. The laser beam modifies the dielectric surface, then the modified areas are chemically activated, and finally, under electroless plating, the activated parts of the dielectric are covered with metal. It should be emphasized that for the first time, using SSAIL the metal was deposited on a curved surface of dielectric. A few types of antenna were investigated, namely, dielectric helix antenna and dielectric antenna mimicking dipole.

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[1] K. Ratautas, et al., Appl. Surf. Sci., Vol. 470, pp. 405-410, 2019.