The Investigation of the Potential for the Generation of Cherenkov Diffraction Radiation Using 3D-printed Plastic Targets

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The generation of polarized radiation by electron beams in the vicinity of dielectric objects has attracted the attention of researchers, due to its potential applications in both measuring beam parameters and generating intense electromagnetic radiation at THz and sub-THz frequencies. One particularly interesting form of this radiation is the Cherenkov diffraction radiation (ChDR), which occurs when high-energy electrons pass along a dielectric boundary. The characteristics of this radiation depend on the properties of the charged particles involved.

By understanding and controlling the properties of electron beams, it is possible to create dielectric targets with various shapes, which can generate ChDR with specific characteristics. To produce such targets with the required level of precision, it is crucial to use techniques for manufacturing dielectric samples with intricate geometries. This can be achieved through 3D plastic printing - fused filament fabrication. However, before implementing this approach, a comprehensive study of the dielectric properties of samples produced via 3D printing is necessary.

In this study, a series of experimental samples from various polymers was produced using the fused filament fabrication technique. The refractive index, absorption, and reflection coefficients were measured. Based on the obtained data, the appropriate materials were selected for the targets manufacture with special geometry for ChDR generation.

A series of experiments were conducted at the MT-25 microtron (Dubna, Russia) to study the generation of ChDR in the 3D-printed target created when the 7 MeV electron beam passes parallel to their surface. After that, the super-radiant spectrum of the emitted radiation on several harmonic lines was analyzed using a spectrum analyzer. The obtained data were compared with those obtained from ChDR generated under similar conditions by a standard teflon target produced by milling cast material.