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Cherenkov diffraction radiation generated by 3D printed plastic samples

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The generation of polarization radiation by electron beams passing near dielectric objects is attracted the attention of researchers due to the potential for introducing this effect to either measure the beam parameters or generate intense electromagnetic radiation beams in THz and sub-THz frequency range. One of the most interesting forms of this radiation is Cherenkov diffraction radiation (ChDR), which arises when high-energy electrons traverse along a dielectric edge. The characteristics of the generated radiation are dependent on the properties of the charged particles.

By understanding and regulating the properties of the electron beam, it is possible to construct dielectric radiators of varying shapes, which will enable the generation of ChDR with distinct properties. In order to produce such radiators with the requisite degree of accuracy, it is essential to use technology for the fabrication of dielectric samples with complex shapes. This may be done via the application of 3D printing by plastics, specifically fused filament fabrication. However, prior to the implementation of this approach, it is essential to conduct a comprehensive investigation into the dielectric properties of the samples produced through 3D printing.

In this study, a series of experimental samples were produced using the fused filament fabrication technique. The set comprised dielectric wafers printed from a variety of polymers, including polyethylene terephthalate glycol (PETG), polylactide (PLA), acrylonitrile butadiene styrene (ABS), high impact polystyrene (HIPS), styrene-acrylonitrile (SAN) and PLA with differing concentrations of impurities, including copper, bronze, carbon and wood fibre powder. A terahertz laser was applied to measure the refractive index and absorption plus reflection coefficient. Based on the data obtained, the most optimal materials were selected, from which test samples with a special geometry were manufactured for the ChDR generation.

A series of experiments was conducted at the MT-25 microtron in Dubna to investigate the generation of ChDR in the created samples when the electron beam passed parallel to their surface. Subsequently, the super-radiant spectrum of the generated radiation on several harmonic lines was investigated using a spectrum analyser. The data obtained were compared with the ChDR generated under identical conditions by a Teflon radiator manufactured by standard milling from cast material.

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Primary authors: KUBANKIN, Alexander (Belgorod National Research University, Belgorod, Russia); BULAVSKAYA, Angelina (Tomsk Polytechnic University, Tomsk, Russia); BALDIN, Anton (Joint Institute for Nuclear Research, Dubna, Russia); KLENIN, Artemy (Belgorod National Research University, Belgorod, Russia); KIDANOVA, Ekaterina (Belgorod National Research University, Belgorod, Russia); BUSHMINA, Elizaveta (Joint Institute for Nuclear Research, Dubna, Russia; Tomsk Polythecnic University, Tomsk, Russia); MILOICHIKOVA, Irina (Tomsk Polytechnic University, Tomsk, Russia; Cancer Research Institute, Tomsk National Research Medical Center of the RAS, Tomsk, Russia); KISHIN, Ivan (Belgorod National Research University, Belgorod, Russia); NOZDRIN, Mikhail (Joint Institute for Nuclear Research, Dubna, Russia); KARATAEV, Pavel (John Adams Institute at Royal Holloway, University of London, Egham, Surrey, United Kingdom); ALEXEEV, Sergei (Joint Institute for Nuclear Research, Dubna, Russia); STUCHEBROV, Sergei (Tomsk Polytechnic University, Tomsk, Russia); KOCHARYAN, Vahan (Institute of Applied Problems of Physics NAS RA, Yerevan, Armenia); MARGARYAN, Vardan (Institute of Applied Problems of Physics NAS RA, Yerevan, Armenia); BLEKO, Vitold (Joint Institute for Nuclear Research, Dubna, Russia)

Presenter: BUSHMINA, Elizaveta (Joint Institute for Nuclear Research, Dubna, Russia; Tomsk Polythecnic University, Tomsk, Russia)

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