Vavilov–Cherenkov radiation and cathodoluminescence in crystals excited by runaway electron beams with energy 10–100 kev

Tarasenko V., Beloplotov D., Sorokin D., Burachenko A., Baksht E., Lipatov E., Lomaev M.

Institute of High Current Electronics SB RAS, Tomsk, Russia, rff.qep.bdim@gmail.com

Runaway electrons (REs) can have an adverse effect in tokamak-type setups [1,2]. REs are able to reach the walls of the vacuum chamber that leads to their heating and partial evaporation of the material [3]. In this regard, studying and development of detectors of REs are actively carried out. Detectors of high-energy charged particles based on the Vavilov-Cherenkov effect is widely distributed [4]. In such detectors, as a rule, diamond crystals are used. Visible and UV radiation (Vavilov-Cherenkov radiation (VCR)) emitted from the diamond when REs pass through the one are registered with a photomultiplier.

In addition to VCR, cathodoluminescence can also be excited in crystal that can lead to erroneous results if the one isn’t taken into account. However, there are no papers where parameters VCR and cathodoluminescence are compared, as well as spectrum of REs is presented.

In this work results of the investigation of spectral and amplitude-time characteristics of radiation in different crystals (synthetic and natural diamonds, ZnSe, CdS, ZnS, ZrO2, Ga2O3, Al2O3, CsI, CaCO3, CaF2) excited by a subnanosecond RE beam with electron energy 10–100 keV, as well as by UV radiation of KrCl excilamp with λ=222 nm are presented. The RE beam was generated in a gas diode filled with low-pressure air or helium at applying high-voltage nanosecond pulses across the one.

It was shown that energy of cathodoluminescence can be significantly greater than the one of VCR in a wide spectral range (180–1100 nm). VCR can be reliably detected in the spectral range from the short-wavelength absorption boundary to the onset of the cathodoluminescence band at exciting of the diamond by the RE beam with electron energy of 10-100 keV.

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