The application of multilayers to generate radiation in a wavelength region from 1 to 20 nm, using electrons in the low MeV energy range.

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Fast electrons passing an interface between materials with an optical contrast generate Transition Radiation (TR). The intensity of TR is proportional to $|\varepsilon_2-\varepsilon_1|^2$, with ε as the electric permitivity. For short wavelengths the optical contrast of materials is low but the radiation yield can be improved by the application of a series of interfaces or even a multilayered system as demonstrated by Yamada et al [1]. Moreover Kaplan et al [2] reported on an improved yield near the absorption edge of the multilayer components as a consequence of an increased contrast. An additional effect around absorption edges of materials is the possibility that $\varepsilon(\omega) > 1$. This is the known condition for the generation of Cherenkov radiation (CR) with frequency ω, during passing of a sufficiently fast charged particle through the material itself. Bazylev et al [3] presented theoretical and experimental evidence of CR generation near the carbon edge (284.1 eV) by combining a polymer foil and electrons with an energy of 1 GeV.
We present the theoretical feasibility to generate both kinds of radiation with a high intensity, using foils or multilayered systems in combination with an electron energy of several MeV. A comparison between the radiation yields for both effects is shown.
We applied classical theory including both phenomena to calculate the TR and CR yields [4]. TR as well as CR are generated within a thin shell $\Delta\theta$ of a cone making an angle θ with the z-axis. For <u>all</u> following calculations we used an electron current of .1 mA. We varied the electron energy from 0.5 to 100 MeV. Our initial calculations concerned radiation emitted around the Si L absorption edge of 12.44 nm (99.7 eV) from electrons passing one silicon foil with a thickness of 10 μm. Below a threshold electron energy of 1.998 MeV there is no generation of CR possible and only TR is generated with a yield gradually increasing to $5.5\text{x}10^9$ photons (integrated over λ = 12.74-12.49 nm). Once the 1.998 MeV CR threshold is surpassed, a fast increase of generated CR to a constant yield of 5.8×10^{11} photons can be observed. In this region TR has not vanished, but the peak is immersed in the CR yield which is considerably larger. Only beyond electron energy of 8.9 MeV a distinct TR peak, increasing to a cross over with the CR yield at electron energy of 56.5 MeV can be observed. The application of an optimized Mo/Si multilayer resulting in 7 periods yields in $1.9\text{x}10^{10}$ photons for the electron energy region below the CR threshold of 1.998 MeV. However after the electrons surpassing this energy, the radiation yield drops rapidly due to an increased absorption as a consequence of an increased period thickness, again leaving CR the dominant phenomenon. The total absorption can be reduced by the application of a system consisting of silicon foils. Calculations revealed that a series of 30 silicon foils with a thickness of 275 nm results in an increasing TR yield dominant to the CR yield over the whole electron energy region higher than the threshold energy of 1.998 MeV. Similarly we calculated the TR and CR yields emitted around the L edge of 1.455 nm (852 eV) for nickel. Below the threshold energy of 9.5 MeV only TR is generated. However, the TR yield for 9 MeV electrons surpassing a Ni/C multilayer and the CR yield for 10 MeV electrons are of the same order of magnitude (10^{10} photons for .1 mA electrons).

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