increases inversely proportional to Γ. At the same time, the peak value of the reflectivity is independent of the grating parameters and can be as high as that of a conventional MM. It was also shown that the reflectivity peak of a single-order LMG is the same as that of a conventional MM for which the material densities have been reduced by a factor of Γ. Therefore, the choice of optimal parameters for the multilayer structure (composition and γ-ratio) remains the same. However, in contrast to a conventional MM, the resolution of an LMG is not limited by the absorption of radiation and is independent of the peak reflectivity. LMGs can therefore be considered as MMs with no physical limitation on their resolution and without loss of peak reflectivity. However, resolution and reflectivity are still limited by the structures that can be fabricated. The analytical approach, thus, confirmed the main results of Ref. [6], where the rigorous coupled-waves approach was numerically solved.

Expressions describing diffraction efficiencies and peak efficiencies for higher orders have been deduced. These results are very similar to those for the zeroth order reflection, differing only in certain details. The main difference is the dependence of the diffraction efficiency on the Γ-ratio: for smaller Γ-ratios, the peak diffraction efficiency approaches, but does not exceed, the peak reflectivity. Also, a decreasing Γ results in a narrowing of the diffraction peak in terms of grazing angle of the incident radiation. The parameters of the multilayer structure (composition and γ-ratio) providing maximum diffraction efficiency proved to be the same as for the reflectivity maximum.

The analytical expressions describing diffraction and reflection of LMGs were demonstrated to be in excellent agreement with those obtained using the rigorous coupled-waves approach. We, therefore, conclude that, in the single-order regime, complex and time-consuming computer codes, based on rigorous theories, are not required for the calculation of the reflection and diffraction by LMGs. Optimization of LMG parameters or deducing structural information, such as intermixing or roughness, of the LMG multilayer from reflectivity measurements are, thus, significantly simplified. This opens several opportunities for the investigation of the fabrication and use of LMGs in the SXR wavelength region.

We also analyzed diffraction and reflection of p-polarized radiation and showed that LMGs can be described analytically for p-polarized radiation as well, in an analogous manner that found for s-polarized radiation. The only difference compared to s-polarized radiation is a reduced efficiency of reflection and diffraction at Brewster's angle of incidence, i.e. when the reflected or diffracted beam propagates perpendicular to the incident one.

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