Multilayer performance optimization for X-ray applications between 0.1 keV and 100 keV.

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Nowadays, applications in X-ray instrumentation call for multilayers optimized for various criteria, including reflectivity (transmissivity) performance at fixed angle or energy, constant reflectivity (transmissivity) over a given energy (angular) range, heat resistance, selectivity, harmonic rejection, and degree of polarization. In this paper we present an optimization of both the peak and the integrated reflectivity of X-ray multilayers for the energy range from 0.1 keV up to 100 keV. To our knowledge the only exhaustive list of material combinations that maximize multilayer reflectivity in the soft x-ray domain was published by Rosenbluth. However, it was limited to a maximum energy of 2 keV and to multilayers composed of pure elements and operating under normal incidence. Our search includes alloys, as they may be essential for a smooth growth and/or for stability under high heat load. The material screening consisted of a list of up to 300 solids having a melting point above 100 ^{o}C and that could be deposited in a sputtering process. When using the complete list, a total of 45000 multilayer combinations are computed for each angle (or multilayer d-spacing) and energy of operation, the only necessary input variables. A list of the most promising multilayer pairs and performance is presented. The results take into account a non-periodic design to minimize absorption effects and other manufacturing concerns such as minimum values for thickness (layer continuity) or for interface roughness (~ 0.3 nm).

Our computer program can also be used to optimize any of the other criteria described above, through minor modification of the code. Some examples will be given.

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