OPTICA APPLICATA online
A quarterly of the Institute of Physics, Wroclaw University of Technology
open access
Wroclaw University of Technology
INSTITUTE OF PHYSICS

Optica Applicata 2006(Vol.36), No.1, pp. 39-50

Effective characteristic matrix of ultrathin multilayer structures

A. J. Haija, W. Larry Freeman, Thomas Roarty

Keywords

multilayers, superlattices, bilayer stacks

Abstract

This paper presents the calculation of the reflectivity, transmissivity and optical constants of ultrathin Cu-Ni multilayer stacks using the characteristic effective medium approximation (CEMA) introduced in an earlier communication. Each of the Cu-Ni multilayer stacks has an identity period of 100 A, Cu – 45 A and Ni – 55 A. Calculations of the reflectivity and transmissivity are executed via the characteristic matrix technique employed in three ways. In the first the characteristic matrix of the Cu-Ni bilayer is calculated and then raised to a power equal to the number of layers in the stack following the characteristic matrix technique. The second is based on the calculation of the characteristic matrix of the bilayer identity period using the effective complex index of refraction of the identity period as derived according to the CEMA. The third is based on the equivalent characteristic matrix of the whole stack represented by one characteristic matrix, also using the CEMA; in this method the equivalent optical constants of the layered structure are also calculated. All calculations are in the visible and for normal incidence. A comparison between results of the first two methods of calculations shows that they are almost identical. However, displaying values using the equivalent effective matrix of the whole structure shows definite quantitative differences throughout the whole studied spectral range. The difference becomes rather noticeable when the number of layers is greater than or equal to six amounting to a minimum total thickness of 600 A for the layered stack as a whole. This establishes a quantitative criterion to the limit beyond which the CEMA cannot be applied.