Study on Scattering Properties between Slightly Rough wafer and Multi-body Defects Particles

Lei Gong[(1)], Zhensen Wu* [(2)], and Chengxian Ge[(2)]
(1) School of Photoelectric Engineering, Xi'an Technological University, Xi'an, Shaanxi, 710021, China
(2) School of Physics and Optoelectronic Engineering, Xidian University, Xi'an, Shaanxi, 710071, China

Extracting effectively the wafer roughness and defect character and diagnosing and controlling the character have important academic significance and realistic value to improve the optical system efficiency and increase the nanometer structure material performance. The detection and control of the optical surface roughness and defect particles is one of the most important research points about the preparation the optical surface and the nanometer/subnanometer structural material. In order to meet the increasing requirements of high-quality optical system, the pure and roughness of optical surface has to be improved.

Based on the wavelet MOM method, the difference field scattering properties between slightly rough wafer and the multi-body defects particles are researched. In view of the half-space problem about wafer and multi-body particles, the computational domain is divided into the total/scattering field domain and objects domain. The integral equations about slightly rough optical surface and the redundant particles are presented from the basic electric field integral equations. The impedance matrix, composite scattering field and the difference scattering field are obtained. Bistatic Radar Cross Section calculation formulas of the composite scattering model are given. The effects of wafer roughness are discussed. Bistatic Radar Cross Section and Difference Bistatic Radar Cross Section are analysis between different material one/double/periodic redundant particles and slightly rough wafer with different incident angle, different depths of particles, different materials of particles and different distances among particles are shown with numerical experiments. In order to get the contributions of particles and wafer in the composite light scattering, the scattering difference field scattering angular distribution of the redundant particles or rough wafer surface are provided. As the most important factor, the position factor is numerically analyzed in detail. Some important conclusions are obtained: 1) In the direction of incident angle, the contribution of particles play the most important role in the composite scattering field. 2)The contribution of distances between particles is the most significantly during (-15°, 15°). 3) The contribution of depth between particles is the most significantly during (-20°, 20°).

The numerical results of this paper can provide theoretical basis for the fields of nondestructive examination and the optical film as well as the optical performance design of the nanometer structure. We can obtain the information of microscopic morphology, evaluate the surface quality of optical system effectively and improve the coating technology of thin film by analysis of scattering characteristics of surface and periodic defects particles, in order to improve the deposition process of optical thin films.