Stress in Molybdenum/Silicon and di-Molybdenum Carbide/Silicon Multilayer Structures

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Stress control is a critical issue for multilayer mirror coatings intended for ultra-high angular resolution applications. In this paper we present the results of an experimental study of the development of stress in molybdenum/silicon (Mo/Si) and di-molybdenum carbide/silicon (Mo_2C/Si) multilayer structures. Multilayers of various Γ's (Γ =the ratio of the hi-density layer thickness to the multilayer period) were prepared by argon gas magnetron sputtering and stresses measured using the laser curvature scanning technique. In both cases the residual stress was found to be compressive for the period and range of relative layer thicknesses studied. The compressive stress decreases with increasing Γ, and increases with decreasing Ar sputtering gas pressure. Stresses in the Mo_2C/Si multilayers are slightly higher than those in Mo/Si multilayers of comparable period and Γ. Annealing resulted in a permanent stress decrease at annealing temperatures larger than 90°C. Complete stress relaxation is achieved after annealing to a moderate temperature, or alternatively at a lower temperature for an extended time. Structural changes in the Si layers are believed to be primarily responsible for the relaxation of stress upon annealing in the Mo_2C/Si. In contrast, changes in the interfacial microstructure in Mo/Si multilayers upon annealing also have a significant effect on the stress relaxation. The differences in the stress levels and thermal annealing behavior in Mo_2C/Si and Mo/Si multilayers, and approaches to the control of stress will be discussed.

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