Space environment experiments of SiC/Mg, Mo/Si and SiC/Si multilayers for astronomical observation

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In extreme ultraviolet (EUV) region of solar spectra, He-II emission line at the wavelength (□) of 30.4nm is important. In this report, SiC/Mg, Mo/Si and SiC/Si period multilayer mirrors were developed for 30.4 nm and near normal incident. Mo/Si can provide more than 70% normal incident reflectivity near 13nm wavelength, but only 23% at □=30.4nm. Therefore, new material combination is required to develop for 30.4nm wavelength. The theoretical reflectivity of SiC/Mg multilayer is as high as 56% at □=30.4nm as the space material of Mg has the absorption edge at 25.2nm. However, Mg is an active element. In this report, their optical stabilities were investigated before and after space environment simulation tests for the purpose of potential application in space extreme ultraviolet observation. All these multilayers were deposited by using magnetron sputtering method on fused silica substrates. Then, the thermal cycling stability and radiation exposure experiments were performed to simulate the space environment, respectively. 6 pieces samples were prepared for each multilayer material combination. There sample were used for thermal cycling test, and there ones for radiation exposure experiment. The thermal cycling tests were performed in vacuum of 1.3E-3Pa. The samples were kept at the low temperature of -45 Celsius degree for 24 hours and at high temperature of 145 Celsius degree for 12hours. The thermal cycle test was repeated three times. The radiation exposure experiment was performed using ^{60}Co as gamma radiation source, and the total radiation dosage is 100 krad (Si). Before and after thermal cycling stability test and radiation exposure experiments, each multilayer mirror was characterized by X-ray Diffracometer and synchrotron radiation, and then made a comparison. From the XRD measurement, no signification change is observed. The reflectivities are all listed in Table 1. It can be seen that the reflectivity of SiC/Mg decreases 3%, and 1% decrease for Mo/Si. The testing results indicate that Mo/Si and SiC/Si multilayer are more stable than SiC/Mg multilayer. After space environment, the reflectivity of SiC/Mg multilayer decreases slightly.

Table 2. Reflectivity of SiC/Mg, Mo/Si and SiC/Si multilayer mirrors before and after tests

Multilayer	thermal cycling stability		radiation exposure experiments	
	before	after	before	after
SiC/Mg	34.0%	31.0%	31.4%	29.4%
Mo/Si	18.6%	17.8%	17.8%	16.8%
SiC/Si	15.3%	15.5%	13.9%	14.0%

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