Fabrication of the beam splitters for 13.9nm x-ray laser applications

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The x-ray laser Mach-Zehnder interferometer is an important tool to measure the electron densities of a laser-produced plasma near the critical surface. The design of a multilayer beam splitter at 13.9nm for soft x-ray laser Mach-Zehnder interferometer is completed based on the standard of designs of maximizing product of reflectivity and transmission of the beam splitter. The performance of semitransparent beam splitter is simulated using interface roughness and interdiffusion. The 100nm silicon nitride membranes of clear area of 10mm×10mm is used as the substrate of a beam splitter in the fabrication. First of all, the deposition thickness of Mo and Si per second is required when Mo/Si multilayer is deposited on the 100nm silicon nitride membrane. The thickness of the Mo layer in the beam splitter is 3.65nm, and the one of Si layer is 3.65nm. Mo/Si multilayer is deposited by using DC magnetron sputtering, and the layer thickness is controlled by time. The base pressure is less than 8×10^{-5}Pa in the process of deposition. The working gas is Ar gas which purity is larger than 99.99% and the working pressure is 0.25Pa. The distance between targets and substrates is 90mm. The power of Mo and Si target are 20W and 20W respectively. The deposition rate of Mo is 0.43nm/s，and the one of Si is 0.31nm/s at above condition. According to the deposition rate, the time needed to stay in different target is controlled by a computer. The figure error of the beam splitter is measured by the ZYGO profiler, which show the beam splitter surface shape precision reached the nanometer magnitude in the center region of a beam splitter, which meeting the request of experiment. Synchrotron radiation measurements in BSRF at 13.9nm provide a reflectivity of 18% and a transmission of 22% shown in Figure 1. From these measurements the reflectivity and transmission product of the beam splitter is close to 4%. The beam splitters were successfully used in a X-ray laser Mach-Zehnder interferometer and interference fringes were obtained.

Key words: x-ray beam splitter multilayer plasma diagnostics